

Understanding underlying processes in bipolar disorder: relationships between circadian and social rhythm stability, appraisal style and mood

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Abstract

Disturbances in both circadian rhythms, such as the sleep-wake cycle, and social rhythms (i.e. daily routines) are well documented in bipolar disorder during mood episodes and periods of wellness. Despite this, current understanding of the nature of the relationship between rhythm instability and mood in bipolar disorder is relatively limited.

Multilevel cognitive models of bipolar disorder suggest that internal appraisal styles may influence the impact of circadian rhythm disruption upon mood (Jones, 2001). The current research therefore aimed to explore relationships between circadian and social rhythm instability, internal appraisal style, and mood in euthymic individuals with bipolar disorder, individuals at behavioural high-risk and non-clinical controls. To investigate the extent to which internal appraisal styles play a unique role in bipolar disorder, individuals with fibromyalgia were also examined due to the similarly chronic nature of the two conditions.

In the first phase of the research, participants completed an online survey, providing a broad impression of the cross-sectional relationships between rhythm instability, appraisal style and mood in a large sample (n=706). In the second phase, a smaller sample (n= 134) took part in a seven day experience sampling and actigraphy study, enabling exploration of

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concurrent and prospective relationships between rhythm instability, appraisal style and mood in everyday life.

Bipolar participants exhibited high levels of objective and self-reported circadian rhythm instability, and also demonstrated a tendency to form negative, internal appraisals of experiences at the state and trait level. For the most part, hypothesized associations between rhythm instability and mood in the bipolar sample were not supported, contradicting Jones' (2001) model of bipolar disorder. Although mood states were significantly related to internal appraisal styles in the bipolar group, such appraisals did not demonstrate a moderating effect. The implications of the findings for theory and practice are discussed.

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This thesis is dedicated to the memory of Andrew Harrison.

Declaration

The data presented in studies 1 and 2 were collected in partnership with Kay Hampshire and Heather Robinson, for the purposes of informing three separate PhD projects exploring; the role of anxiety in bipolar disorder (Kay Hampshire), mood management strategies in bipolar disorder (Heather Robinson), and the role of circadian and social rhythm instability in bipolar disorder (the present thesis).

In study 1, Kay Hampshire and Heather Robinson contributed to the promotion of the study (e.g. via online forums and social media) for the purposes of recruiting individuals with a diagnosis of bipolar disorder and non-clinical individuals from the general population. All measures completed in study 1 contributed to the present thesis, whilst the HPS data also contributed to the other two PhD projects. The HADS data collected in study 1 also contributed to the anxiety PhD.

In study 2, Kay Hampshire and Heather Robinson significantly contributed to the development of study materials, such as the ESM diary items, and the recruitment of individuals with a diagnosis of bipolar disorder and non-clinical individuals from the general population. In study 2, the SRM, sleep diary and actigraphy data were collected solely for the purposes of the present thesis. Participants completed sections D, E, F and K in the ESM diary solely to inform the mood management PhD project, whilst sections G and H were completed solely for the purposes of the present thesis.

The research presented within this thesis has not been submitted for the award of a higher degree elsewhere.

Rationale for Alternative Format

The current thesis is presented in the alternative format. This decision was made based upon the desire to maximise dissemination of the findings, in addition to nature of the research, i.e. systematic reviews and empirical studies, which lends itself to this type of format.

Construction of the Alternative Format

Chapter 1: Introduction

The thesis begins with an overview of the research area, providing a description of key concepts and themes. The nature and course of bipolar disorder is briefly summarized, followed by an introduction to psychological models of bipolar disorder and the concept of circadian instability.

Chapter 2: Circadian and Social Rhythm Instability in Bipolar Disorder: A Systematic Review

Following the introduction, a systematic review of the literature concerning sleep, activity and social rhythm instability in bipolar disorder is presented. The review provides an in-depth background to the area of circadian instability in bipolar disorder, and highlights gaps in the existing literature which the current thesis aims to address.

Chapter 3: Cognitive Styles Throughout the Course of Bipolar Disorder

A critique of available evidence regarding the role of attributions, appraisal styles and attitudes in bipolar disorder is offered, drawing attention to multilevel cognitive models of bipolar disorder which the current thesis aims to assess. Relationships between cognitive style and mood in bipolar disorder are discussed, with reference to cross-sectional and prospective studies in clinical and non-clinical populations.

Chapter 4: Overview and Justification of Methods

An explanation of the methodologies employed in studies 1 and 2 is then presented, outlining the strengths and limitations of online surveys, actigraphy and the experience

sampling method. This is followed by an outline of the overarching aims of the thesis, summarizing the key hypotheses tested in studies 1 and 2.

Chapter 5: Study 1- Associations between Circadian and Social Rhythm Instability, Appraisal Style and Mood in Individuals with and without Bipolar Disorder: Results of a National Online Survey

An online investigation into the cross-sectional relationships between rhythm instability, appraisal style and mood in bipolar disorder is presented. The results of the study indicate significant associations between self-reported sleep disturbance, internal appraisal style, and negative mood in bipolar disorder. The implications and limitations of the study are discussed, highlighting areas requiring further clarification.

Chapter 6: Study 1- Assessment of the Relationship between Circadian and Social Rhythm Instability, Internal Appraisal Style and Mood in Bipolar Disorder using Actigraphy and Experience Sampling

A study into the ecological assessment of rhythm instability, internal appraisal styles, and mood in everyday life in bipolar disorder is described. The seven day study highlights significant momentary relationships between internal appraisal style and the intensity and variability of mood states in bipolar disorder. Implications of the findings regarding multilevel cognitive models of bipolar disorder are discussed.

Chapter 7: General Discussion

The integrated findings and research implications from studies 1 and 2 are presented in a final discussion chapter, with reference to the overall aims of the thesis. Implications for

both theory and clinical practice are presented, whilst acknowledging the limitations of the research. Directions for future research are also offered.

Chapter 1: Introduction

1.1 Signs and Symptoms of Bipolar Disorder

Bipolar disorder is a severe and enduring mental health condition characterised by extreme shifts in high and low mood (Johnson & Leahy, 2004). It is estimated that around 1 to 2% of the general population will receive a diagnosis of bipolar disorder, however issues around misdiagnosis suggest that this estimate is likely to be much higher in reality (Fagiolini, Forgione, Maccari et al., 2013).

Typically the course of bipolar disorder is depicted by periods of extreme irritability and elation (i.e. manic episode), and extreme sadness (i.e. depressive episode), with intermediate periods of ‘euthymia’ (i.e. “normal” mood in the absence of clinically significant symptoms). Manic episodes are characterised by increases in self-esteem, distractibility and goal-directed activity, often accompanied by a decreased need for sleep and racing thoughts (American Psychiatric Association, 2000). Depressive episodes are characterised by a loss of self-esteem, excessive feelings of guilt, loss of interest or pleasure from activities, and low energy (American Psychiatric Association, 2000). Both insomnia and hypersomnia (i.e. sleeping too much) are common during episodes of depression. Mixed episodes are also common in bipolar disorder, characterised by symptoms that fulfil criteria for both depression and mania over a period of at least one week (Targum & Nierenberg, 2011).

1.2 Diagnostic Subtypes

The term ‘bipolar disorder’ encompasses a wide variety of mood disorders ranging in severity. The two most common forms are Bipolar I and Bipolar II disorder. To receive a diagnosis of Bipolar I disorder, an individual must experience at least one manic or mixed episode (American Psychiatric Association, 2000). Many individuals who receive this

diagnosis also experience episodes of depression over the course of the disorder. In the case of Bipolar II disorder, individuals experience episodes of depression alongside milder periods of mania referred to as ‘hypomania’ (American Psychiatric Association, 2000). The characteristic symptoms of hypomania are similar to those experienced during mania, but are shorter in duration and are not associated with the same degree of disruption to normal functioning. A less extreme form of bipolar disorder known as ‘cyclothymia’ is characterised by recurrent periods of hypomania in addition to milder periods of depression or ‘dysthymic mood’ (Jones, Lobban & Cooke, 2010).

1.3 Impact of Bipolar Disorder

The course of bipolar disorder can differ greatly from person to person, with differences regarding the type, length and frequency of mood episodes. However, for many people the impact of bipolar disorder can be devastating, putting strain on interpersonal relationships, causing financial problems and impeding vocational aspirations (Michalak, Yatham, Kolesar & Lam, 2006). Furthermore, accumulating evidence indicates that relatives and carers of individuals with bipolar disorder tend to experience high levels of psychiatric distress and are also at increased risk of physical health problems (Perlick, Rosenheck, Miklowitz et al., 2007; Rodrigo, Fernando, Rajapakse, et al., 2013; Steele, Maruyama & Galynker, 2010).

The impact of bipolar disorder to society as a whole is considerable, with recent evidence suggesting costs to the National Health Service (NHS) in the region of £342 million per year (Young, Rigney, Shaw et al., 2011). A report published by McCrone and colleagues (2008), indicates that this figure is much higher when taking into account the associated costs of unemployment (i.e. £5.2 billion in 2007).

1.4 Treatment

Given the prevalence of bipolar disorder, in addition to the associated burden placed upon the individual, their friends and relatives, and wider society, the development of effective treatment methods is a vital area of current research. Although bipolar disorder is primarily treated with medication, there is accumulating evidence demonstrating the limitations of a solely medical approach. For many individuals, medication alone is inadequate in tackling the range of symptoms which accompany bipolar disorder (Machado-Vieira, Manji & Zarate, 2010). Additionally, mood-stabilising medication can cause unpleasant side-effects such as nausea, weight-gain and tremors (Dols, Sienaert, van Gerven et al., 2013). Recent research suggests that such adverse side-effects, in addition to negative beliefs around medication, are strongly related to treatment adherence issues in bipolar disorder (Arvilommi, Suominen, Mantere et al., 2014). This is concerning when one considers evidence linking medication non-adherence to suicide attempts in bipolar disorder (Perlis, Ostacher, Miklowitz et al., 2010).

Following the National Institute for Health and Clinical Excellence (NICE) guidance for bipolar disorder (NICE, 2006), it is recommended that long-term treatment incorporates adjunctive psychotherapy alongside medication. Whilst there is evidence to suggest that various psychological approaches generate significant therapeutic benefit for individuals with bipolar disorder (Hollon & Ponniah, 2010; Morriss, Faizal, Jones et al., 2007), there is also evidence to the contrary (Lynch, Laws & McKenna, 2010; Scott, Paykel, Morriss et al., 2006). Variation in treatment outcome across different bipolar subtypes, in addition to the impact of illness severity (Reinares, Sánchez-Moreno & Fountoulakis, 2014), emphasizes the need to focus research on informing and improving psychological treatment approaches for individuals with bipolar disorder.

1.5 Models of Bipolar Disorder

As psychological treatment approaches are informed by theory, the validation and evaluation of current models of bipolar disorder is essential to making improvements in this area. Psychological interventions which are currently offered by the NHS, such as cognitive behavioural therapy (CBT), were originally informed by early models of cognition which emphasize the development of trait-like, maladaptive thinking styles as a consequence of negative life experiences (Newman, Leahy, Beck et al., 2002; Beck, 1967). Although these early theories have been fundamental in the development of psychological approaches to treating bipolar disorder, they are also limited in their ability to offer detailed explanations of the underlying processes involved in mood change. More recent multilevel cognitive models offer greater detail into these processes, and therefore present new avenues for research into therapeutic mechanisms which will inform and improve psychological treatment approaches.

1.6 Circadian and Social Rhythm Instability

Over the last fifteen years, research into factors implicated in bipolar disorder has highlighted the impact of disturbances in circadian and social rhythms. Circadian rhythms are endogenous, biological processes which follow an approximate 24-hour pattern, such as the sleep-wake cycle (Gallagher, Nelson & Weiner, 2003). Social rhythms reflect the stability of daily routines, which consist of activities performed regularly such as having lunch between 12pm and 1pm each day (Monk, Flaherty, Frank et al., 1990). In bipolar disorder, evidence of disturbances in sleep patterns (Harvey, Talbot & Gershon, 2009), social rhythms (Frank, Gonzalez & Fagiolini, 2006) and the secretion of hormones (Hallam, Begg, Olver & Norman, 2009), indicates an underlying instability of these rhythms. This was first acknowledged by Wehr and colleagues (1983), and subsequently developed into the ‘instability model’ (Goodwin & Jamison, 1990).

Current evidence not only suggests that circadian and social rhythm instability is present before diagnosis in behavioural high-risk populations (Ankers & Jones, 2009; Bullock, Judd & Murray, 2011; Meyer & Maier, 2006; Ritter, Marx, Lewtschenko et al., 2012), but also indicates that events associated with circadian and social rhythm disruption precipitate manic episodes in bipolar disorder (Malkoff-Schwartz, Frank, Anderson et al., 1998; 2000). However, the processes underlying the relationship between rhythmic disruption and mood change remain unclear and under-researched.

1.7 A Multilevel Cognitive Model of Circadian and Social Rhythm Instability

Acknowledging the importance of rhythm instability in bipolar disorder, Jones (2001) developed a multilevel cognitive model, applying the ‘Schematic, Propositional, Analogical and Associative Representation Systems’ (SPAARS) model of emotion (Power & Dalgleish, 1997) to describe the processes by which rhythmic disturbances translate into mood change. According to the model, events which disrupt circadian rhythms lead to physiological and/or cognitive changes in state. For example, becoming unemployed may disrupt sleeping patterns which in turn could cause physical restlessness. According to Jones (2001), the way in which these changes in state are appraised influences the impact of circadian rhythm disrupting events upon mood (see Appendix 1). It is suggested that a change in state may be appraised at multiple cognitive levels, some more automatic than others. This multilevel approach to bipolar disorder is therefore able to account for conflicting emotional states and the development of mixed episodes.

It is proposed that internal appraisals, characterised by attributing such changes to the self (e.g. “I feel restless because I am creative and have lots of great ideas”), underlie the extreme shifts in mood which typify bipolar disorder (Jones, 2001).

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**Circadian and Social Rhythm Instability in Bipolar Disorder:
A Systematic Review**

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pp. 28-91

2.1 Abstract

Background: Despite growing support for theories which emphasize the importance of circadian and social rhythms in bipolar disorder, the processes by which these disturbances impact on mood remain unclear.

Objective: To review evidence regarding the role of circadian and social rhythms throughout the course of bipolar disorder.

Method: An electronic database search was conducted to identify relevant papers. Papers were also identified by contacting experts in the field.

Results: Preliminary evidence of low activity rhythm amplitudes, low social rhythm regularity, and high sleep pattern variability in populations at behavioural high-risk for bipolar disorder, was identified. Poor social rhythm regularity, in addition to lower average activity, was observed during periods of euthymia in clinical populations. However, objective versus self-report assessments of sleep quality produced inconsistent findings. Sleep duration was significantly associated with symptoms of mania and depression in euthymic populations.

Conclusion: Circadian and social rhythm abnormalities may represent an underlying vulnerability for bipolar disorder in non-clinical populations. Whilst such abnormalities are apparent in clinical populations also, there is a great deal of contradictory evidence in this area. Further research is required to assess the processes underlying relationships between rhythm instability and mood in bipolar disorder.

2.2 Introduction

This review begins with a justification for an up to date systematic review of circadian and social rhythm instability in bipolar disorder, noting important findings reported by previous reviews in this area. This is followed by a description of the methodologies employed in circadian and social rhythm research referred to throughout the paper. An explanation of how included studies were identified is then presented, before highlighting the methodological limitations of these studies. The review then provides an overview of the evidence, before discussing the implications of these findings.

A number of studies point to the central role of circadian rhythms in bipolar disorder (Barbini, Bertelli, Colombo & Smeraldi, 1996; Lam & Wong, 1997; Mansour, Wood, Chowdari et al., 2005; Shi, Wittke-Thompson, Badner et al., 2008). Circadian rhythms refer to 24 hour, biological patterns such as the sleep-wake cycle and body temperature (Duffy, Kronauer & Czeisler, 1996). Disturbances in these rhythms have been implicated in various psychological and physiological conditions, including post-traumatic stress disorder and cancer (Yehuda, Golier & Kaufman, 2005; Pati, Parganiha, Kar et al., 2007).

According to the ‘instability model’ (Goodwin & Jamison, 1990) circadian rhythm disruption can trigger mood change in bipolar disorder, leading to the onset of mood episodes. This is supported by studies demonstrating the psychological effects of jet-lag, where disruption of circadian rhythms significantly correlated with incidences of mania and depression (Jauhar & Weller, 1982; Katz, Knobler, Laibel et al., 2002; Proudfoot, Whitton, Parker et al., 2012; Young, 1995). Changes in sleep duration are also highlighted in the diagnostic criteria for both manic and depressive episodes under the DSM-IV (American Psychiatric Association, 2000). Furthermore, a systematic review examining prodromes in bipolar disorder found disturbed sleep to be the most commonly reported early symptom of mania, reported by 77% of patients (Jackson, Cavanagh & Scott, 2003).

Murray and Harvey (2010) presented multiple lines of evidence for a causal relationship between circadian disturbance and episode onset, such as evidence that bipolar episodes are closely preceded by changes in season (Murray, 2006). More recently, Boland and Alloy (2013) conducted a review of the literature concerning sleep disturbance and cognitive deficits in bipolar disorder. The authors cited evidence of positive relationships between sleep disturbance and symptoms of hypomania, previous suicide attempts, and number of depressive episodes (Eidelman, Talbot, Gruber et al., 2010; Sylvia, Dupuy, Ostacher et al., 2012). The review also highlighted studies demonstrating abnormalities in REM (i.e. rapid eye movement) sleep and increased variability of sleep patterns during periods of remission. These findings emphasize the persistence of sleep disturbance throughout the course of the disorder.

Another related factor which has been implicated in bipolar disorder, is social rhythm regularity. Social rhythms refer to daily patterns of behaviour, or routines, made up of a number of regular activities such as getting out of bed, going to work, and having lunch (Monk, Flaherty, Frank et al., 1990). Individuals who perform a large number of activities regularly, and therefore adopt a structured daily routine, are said to have high social rhythm regularity. According to the 'social zeitgeber hypothesis', social rhythms are strongly influenced by 'social zeitgebers', i.e. external cues such as light, time and people, which promote the entrainment of circadian rhythms (Ehlers, Frank & Kupfer, 1988). It is proposed that significant life events, such as the loss of a loved one, disturb social zeitgebers and reduce social rhythm regularity, which in turn directly triggers changes in circadian rhythms. For example, the loss of a partner may also mean the loss of an important external cue for going to bed and getting up at a certain time. This disruption in social zeitgebers may therefore lead to increased variability in sleeping patterns and sleep duration. It is then proposed that this disruption in circadian rhythms triggers significant changes in affective states, leading to the onset of mood episodes in vulnerable individuals.

Ehlers et al. (1988) propose that the effects of infrequent circadian rhythm disruption, such as an annual long-haul flight to a holiday destination, are mild for non-vulnerable individuals. For individuals at high-risk of affective disorders however, this initial disruption can develop into “a state of ongoing desynchronization”. In support of this theory, a review by Grandin, Alloy and Abramson (2006) reported evidence of poor social rhythm regularity in individuals with bipolar disorder, including preliminary evidence that poor social rhythm regularity may actually precede episodes of mania and depression.

Previous reviews in this area have acknowledged that the underlying processes involved in the relationship between rhythm instability and mood in bipolar disorder remain unclear (Murray & Harvey, 2010). Examination of individuals considered at high-risk for bipolar disorder, in addition to further research assessing the efficacy of interventions which target circadian and social rhythms in bipolar disorder, has therefore been strongly advocated (Boland & Alloy, 2013; Grandin et al., 2006; Murray & Harvey, 2010).

This review builds upon previous reviews by examining investigations of sleep, activity and social rhythm instability in populations at behavioural high-risk for bipolar disorder, whilst also providing an update on evidence concerning circadian and social rhythm instability in clinical populations. This is intended to illuminate potential pathways by which circadian and social rhythms and mood interact. Thus the present review aims to; i) critically appraise evidence of sleep, activity and social rhythm abnormalities in bipolar disorder and at-risk populations; ii) assess how sleep, activity and social rhythm instability interacts with mood in these populations, and; iii) assess the efficacy of interventions which target rhythmic disturbances in bipolar disorder.

2.2.1 Definition of Applied Methodologies in Sleep, Activity and Social Rhythm Research

Sleep is often assessed using polysomnography (PSG) or actigraphy. PSG is a laboratory-based method in which electrodes are attached to a person's body to record biological

information, such as brain activity and heart rhythm, while the subject sleeps (Kiely, Delahunty, Matthews & McNicholas, 1996). PSG permits the distinction between different stages of sleep, such as REM and non-REM, based on brain activity. REM sleep is a form of light sleep which has been associated with emotional processing and the consolidation of memories (Walker & Van der Helm, 2009; Diekelmann & Born, 2010). REM sleep is often characterized in terms of ‘REM latency’ and ‘REM density’, respectively referring to the time period between sleep onset and the first REM period, and the frequency of rapid eye movements during the sleep period (Mattice, Brooks & Lee-Chiong, 2012). All other stages of sleep are referred to as non-REM (or NREM) sleep, often described as “deep” sleep, where brain activity becomes significantly slower (Espie, 2006).

Actigraphy is a relatively non-invasive method of measuring both activity and sleep patterns, over consecutive days and nights. Participants are required to wear an ‘actiwatch’, normally on their wrist, which contains an accelerometer (Tryon & Williams, 1996). The accelerometer is sensitive to movement and records activity across epochs. Often participants are also required to complete daily sleep diaries whilst wearing the actiwatch, providing subjective sleep information such as the time they went to bed and the time at which they believe they fell asleep (Espie, 1991). Sleep patterns may also be assessed subjectively using ‘ChronoRecord’ (Bauer, Grof, Gyulai et al., 2004). ChronoRecord is a computerized methodology completed daily, whereby participants indicate whether they were awake, asleep or resting for each hour in the previous 24 hour period. This information is then used to calculate the duration of sleep periods over the course of study.

Social rhythm regularity is assessed using the Social Rhythm Metric (SRM; Monk et al., 1990). The SRM consists of 15 items which represent activities believed to contribute to common routines. The measure also includes two optional write-in items whereby respondents may offer details of additional regular activities that they perform. Completed daily, respondents indicate how many of the activities they have performed and at what time these activities occurred. Activities which occur at least 3 times over the week, within the

same 45 minute time period, are classed as regular. A shorter version the SRM has also been developed, which assesses social rhythm regularity based upon 5 key activities (SRM-5; Monk, Frank, Potts & Kupfer, 2002). To assess trait-like social rhythm regularity, Shen, Alloy, Abramson and Sylvia (2008b) developed a modified version of the SRM, referred to as the SRM-T. The SRM-T is completed once, requiring participants to indicate which activities they have performed regularly over the previous month.

2.3 Method

2.3.1 Search Strategy

Initial search terms were chosen on the basis of their relevance to the research question (i.e. it was important to identify studies of bipolar populations related to sleep, social rhythms and activity patterns). Further search terms were identified through discussion with experts in the field of circadian rhythms in bipolar disorder, in addition to the use of the thesaurus tool offered by online research databases.

The search was performed within the following databases; PsycINFO, MEDLINE, AMED and CINAHL. The search for papers relating to "bipolar*" OR "cyclothymia" OR "mania" OR "hypomania" OR "manic-depression" was combined with the search for "insomnia" OR "PSG" OR "actigraph*" OR "activity pattern" OR "activity level" OR "daily routine" OR "daily activities" OR "activity cycle" OR "periodicity" OR "ambulatory monitoring" OR "sleep" OR "social rhythm" OR "circadian" OR "biological rhythm" OR "physical activity". The search was performed solely within the abstracts of papers to improve the specificity of the results.

2.3.2 Inclusion and Exclusion Criteria

Papers were only included if the study concerned participants who were aged 18 and over. Literature reviews, meta-analyses, case studies, dissertation abstracts, letters, and any papers not available in English were excluded. Where possible, these criteria were applied during the initial search by the use of search limiters. Where research databases did not offer the option to exclude studies by age of population, language, or methodology, these criteria were applied after the initial search during the ‘screening stage’ whereby the title and abstracts of the identified papers were read by the first author.

During this screening stage, any papers which were deemed irrelevant to the research question (i.e. focused solely on genes, medication, brain activity or hormones) were excluded as such factors were deemed beyond the scope of the review. Only studies of individuals who met criteria for a diagnosis of bipolar disorder, and/or were classified as being at-risk for developing bipolar disorder, were included. All duplicate results were removed.

2.3.3 Assessment of Quality

After the screening stage, papers were assessed for methodological quality using the online CASP resources (Critical Appraisal Skills Programme, 2010). The CASP tools list key questions that should be asked when assessing methodological quality to aid the decision of whether or not to include a particular study in a review. Although the CASP tools are yet to be formally validated, they provide a flexible and holistic framework for assessing the methodological rigour of various research designs. As all papers identified in the present review were either case control studies or randomised controlled trials (RCTs), only the CASP tools relating to these two methodologies were referred to.

In the present review, the CASP tools were applied to assess each study in terms of the measurement of circadian disturbance and/or mood, the specificity of the results presented,

and the generalizability of the findings (i.e. whether the samples studied were representative of the wider population). It was important to ensure that all included studies had employed previously validated measures of circadian disturbance and/or mood, to achieve an adequate level of accuracy and reliability in the findings across studies.

It was equally important to ensure that the findings of included studies could be generalised to the wider bipolar and/or high-risk population. Therefore any studies which employed unrepresentative samples (i.e. only studying bipolar participants meeting criteria for obesity or substance abuse) were excluded at this stage.

To ensure that all included studies reflected findings specific to individuals with bipolar disorder (rather than mood disorder populations in general) any studies which only reported results based on combined affective disorder populations were excluded at this stage.

2.3.4 Grouping of Studies

The database search identified 3,033 papers. Limiters were then applied where possible, such that only papers available in English, concerning adult populations which were not case studies, literature reviews or meta-analyses, would be retrieved. This left 639 papers to be screened for eligibility. During this screening phase, the abstracts of each paper were read by the first author to establish whether or not the remaining inclusion/exclusion criteria had been met. Any duplicate results were also excluded. One paper was excluded as neither the British Library nor any online database held a full copy.

This left 213 papers to be assessed for methodological rigour using the CASP tools. Of the 213 studies, 171 were excluded due to concerns regarding the measurement of circadian disturbance and/or mood (i.e. using unvalidated methods; $n= 86$), not providing results specific to bipolar disorder (i.e. combining data from a bipolar sample with data from another mental illness population in the analysis; $n= 29$), and studying unrepresentative samples

(n=56). This left 42 studies which were deemed to be of suitable quality and relevance to the research question.

The authors of these 42 papers were then contacted to enquire about key papers relating to circadian and social rhythms in bipolar disorder which they were aware of. Of the 21 authors who were contacted, 9 responded. A total of 46 papers were suggested by these authors, of which 22 had already been identified by the database search. The remaining 24 papers were then examined by the first author to check for eligibility and methodological rigour as described above (see Figure 1 for more detail). A total of 3 papers were found to be of suitable quality and were added to the results of the database search.

Overall 45 papers were included in the present review. The high degree of variation in study design and methodological quality between studies, indicated that pooling the data together may increase the likelihood of systematic error (see Ahlbom, 1993). Therefore a meta-analysis was not performed.

Studies were grouped primarily according to area (i.e. sleep, activity and social rhythms), and then categorised according to the population under investigation (i.e. studies of non-clinical high-risk populations versus clinical bipolar populations). The results are presented such that sections 2.4.3 to 2.4.5 relate to aims 'i' and 'ii' outlined above, whilst section 2.4.6 relates to aim 'iii'.

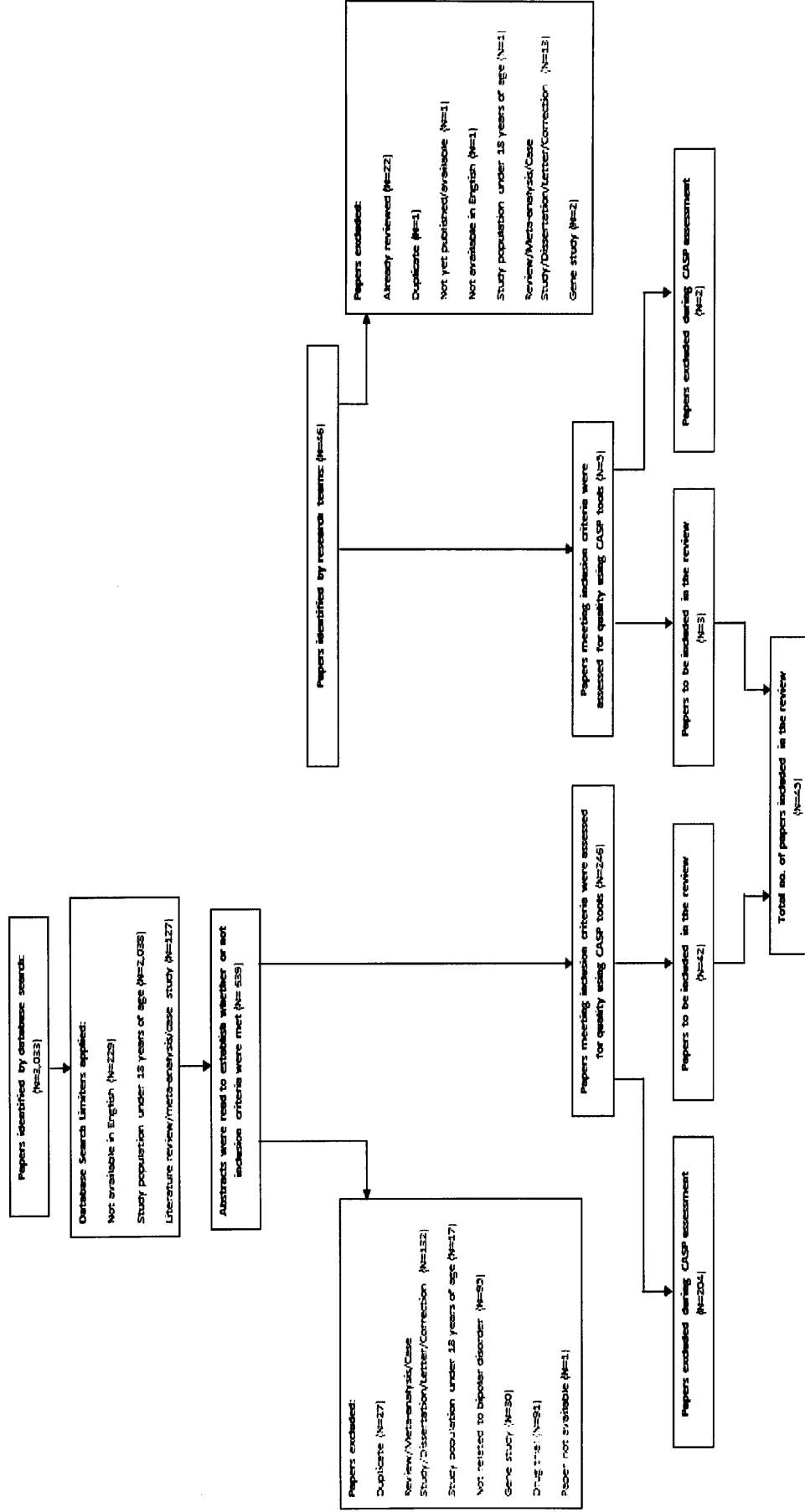


Figure 1. Study selection process

2.4 Results

2.4.1 Overview of Studies

A description of the selected studies is presented in Table 1. Due to the nature of research into circadian and social rhythms, it is often necessary to collect data over multiple time points, thus almost all of the studies identified could be described as longitudinal to an extent. In the present review, quantitative non-intervention studies were categorised as cross-sectional, longitudinal or semi-longitudinal. Cross-sectional studies were defined as those which collected data at a single point in time. Longitudinal studies were defined as those which collected data over multiple time points to consider predictive relationships between variables. Semi-longitudinal studies were defined as studies which collected data over multiple time points but then averaged these data to produce total scores and carry out correlational analyses (e.g. in the case of studies assessing social rhythms over seven days). The 45 studies selected for review included 1 qualitative study, 4 cross-sectional studies, 8 intervention studies, 11 longitudinal studies, and 21 semi-longitudinal studies.

Table 1. Summary of studies identified by review

Author (Date)	Design	Location	Participants (N)	Diagnostic Classification	Measure of CR/SR	Key Findings
Ankers & Jones (2009)	S-L	UK	HR (31) CO (24)	SCID, HPS	Actigraphy, Sleep Diary	HR demonstrated lower RA, shorter sleep duration, and greater sleep variability compared to CO. No group differences in IV or IS.
Bauer et al. (2006)	L	Germany	BDI (37) BDII (22)	DSM-IV Criteria	ChronoRecord	Decrease in sleep/bedrest followed by shift towards (hypo)mania the following day. Increase in sleep/bedrest followed by shift towards depression the following day.
Bauer et al. (2009)	L	Germany	BP (101)	DSM-IV Criteria	ChronoRecord	Changes in sleep duration more consistently associated with changes in mood than changes in sleep onset/offset.
Benedetti et al. (2007)	I	Italy	BDI (39)	DSM-IV Criteria	Impact of LT & TSD (Actigraphy)	26 patients demonstrated anti-depressant response to chronotherapy. Responders also demonstrated increase in activity levels post-treatment.
Boland et al. (2012)	L	USA	BDII (134) CO (197) CYC (50)	GBI/SADS-L	SRM-T, LES	BP exhibited lower SRM scores than CO and also experienced a greater number of SRD-E.
Bullock et al. (2011)	S-L	Australia	BDI (15) HR (36) LR (36)	CIDI-Auto	SRM-5	HR exhibited lower SRM scores than LR. No sig. difference between BDI & HR.
Bullock & Murray (2013)	S-L	Australia	HR (35) LR (35)	GBI/CIDI	Actigraphy, Sleep Diary	LR exhibited higher RA than HR. The association between RA & GBI-Mania was significantly larger than the association between RA &

Table 1. (continued)

Author (Date)	Design	Location	Participants (N)	Diagnostic Classification	Measure of CR/SR	Key Findings
Colombo et al. (1999)	I	Italy	BP (206)	DSM-III-R/ DSM-IV Criteria	Impact of TSD	GBI-Depression. No group differences in SOL, IV or IS. 4.85% of the sample demonstrated a shift towards mania post-treatment with 5.83% of the sample demonstrating a shift towards hypomania.
Dauphinais et al. (2012)	I	USA	BP (44)	MINI	Impact of LT/NI	No difference in treatment effect between LT & NI. Both treatments demonstrated an anti-depressant effect.
Eidelman et al. (2010)	L	USA	BP (22) CO (22)	SCID	PSG	BP demonstrated higher REM density than CO. REM density was positively associated with depressive symptoms at 3 month FU.
Fossion et al. (1998)	S-L	Belgium	BDI (14) BDII (14) UP (14)	RDC	PSG	No group differences in sleep architecture.
Gershon et al. (2012)	S-L	USA	BDI (32) CO (36)	SCID	Actigraphy, Sleep Diary PSQI, ISI	BDI scored higher on PSQI and demonstrated more variable TIB, SE and TWT than CO. BDI also exhibited poorer SE and higher WASO than CO. The positive relationship observed between SOL & NA was stronger in BDI than CO.
Gruber et al. (2009)	C	USA	BP (2024)	ADE	CMF Sleep items	TST higher in BDI and BDII than BD-NOS. No group differences in SV or sleep duration.

Table 1. (continued)

Author (Date)	Design	Location	Participants (N)	Diagnostic Classification	Measure of CR/SR	Key Findings
Gruber et al. (2011)	C	USA	BP (196)	ADE	CMF Sleep items	Lower TST was associated with increased symptoms of mania. Greater SV was associated with increased symptoms of mania and depression.
Harvey et al. (2005)	S-L	USA	BDI (20) IP (20) CO (20)	SCID	Actigraphy, Sleep Diary, IDI, PSQI, SDQ, DBAS	55% of BDI met diagnostic criteria for insomnia, with 70% scoring above 5 on the PSQI. BDI & IP demonstrated greater SOL and DBAS scores than CO. TST greater in BDI than IP or CO.
Hudson et al. (1992)	S-L	USA	BP (19) UP (19) CO (19)	SCID	PSG	No difference in sleep architecture between BP (manic) and UP (depressed). Both groups demonstrated lower TST, SE & REM latency, & higher REM density than CO.
Indic et al. (2011) -Study 1 -Study 2 -Study 3	S-L	Australia Australia Italy	HR (35), LR (35) BDI (15), CO (15) BDI (51)	GBI DSM-IV Criteria/GBI DSM-IV Criteria	Actigraphy	VI was positively associated with risk and diagnosis of BD. VI was associated with mania but not depression.
Indic et al. (2012)	S-L	Italy	BDI (12) BDII (12) UP (12)	SCID	Actigraphy	BDII demonstrated lower VI than BDI, who exhibited lower VI than UP.
Jones et al. (2005)	S-L	UK	BDI (19) CO (19)	SCID	Actigraphy, Sleep Diary SRM-I	No group differences in R.A, SRM-I, or SV. BDI demonstrated lower IS & lower overall activity than

Table 1. (continued)

Author (Date)	Design	Location	Participants (N)	Diagnostic Classification	Measure of CR/SR	Key Findings
Jones et al. (2006)	S-L	UK	BDI (19) BDII (1) CO (19)	SCID	SRM	CO, BDI also exhibited greater IV than CO. None of the CR/SR variables were associated with mood symptoms. No differences in SRM between BP & CO, however BP demonstrated a lower frequency of daily activities.
Kaplan et al. (2011)	L	USA	BDI (51) BDII (5) CO (55)	SCID	DSISD, Sleep Diary IDS, BDI-II	1 in 4 BP met criteria for hypersomnia.
Kuhs & Reschke (1992)	S-L	Germany	BP (12) UP (25)	DSM-IV criteria	Actigraphy, Sleep Diary	No significant group differences on any C/SR variable. However trend for higher activity levels in UP than BP.
Liebenhuf et al. (1996)	L	USA	RC (11)	SCID	Sleep Diary	Increased sleep duration reduced the probability of being in a (hypo)manic episode the following day.
Malkoff-Schwartz et al. (1998)	C	USA	BDI (39)	SADS-L/SCID	LEDS	SRD-E tended to be experienced during pre-episode periods than during control periods.
Malkoff-Schwartz et al. (2000)	C	USA	BDI (66) UP (44)	SADS-L/SCID	LEDS	Incidence of SRD-E during pre-onset periods was higher in manic BDI than depressed or cycling BDI.

Table 1. (continued)

Author (Date)	Design	Location	Participants (N)	Diagnostic Classification	Measure of CR/SR	Key Findings
Meyer & Maier (2006)	S-L	Germany	HR (56) UR (37) CO (48)	SCID/HPS/MPT	SRM-5	HR demonstrated greater sleep pattern variability and scored lower on the SRM-5 than CO. UR & CO did not significantly differ from one another. There were no group differences in sleep duration.
Miklowitz et al. (2007)	I	USA	BDI (197) BDII (90) BDNOS (5)	SCID	Impact of IPSRT, FFT, CBT vs CC	No difference in treatment outcome between the 3 psychotherapies. BP who received psychotherapy were 1.58 x more likely to be well during any study month than those who received CC, and also demonstrated shorter times to recovery. No differences in rates of attrition between CC and psychotherapy.
Millar et al. (2004)	S-L	UK	BDI (19) CO (19)	DSM-IV Criteria/SCID	Actigraphy, Sleep Diary	No group differences in actigraphic SE or SOL. BDI demonstrated more variable sleep duration and night-time waking compared to CO, and also reported longer SOL & sleep duration. Sleep duration variability, self-reported sleep duration & self-reported SOL distinguished BDI from CO.
Murav et al. (2011)	Q	USA	BDI (25) BDII (7)	MINI	Themes	BP reported getting sufficient and regular sleep as important strategies for regaining and maintaining wellness. Many

Table 1. (continued)

Author (Date)	Design	Location	Participants (N)	Diagnostic Classification	Measure of CR/SR	Key Findings
Nofzinger et al. (1991)	S-L	USA	BDI (13) BDII (12) NP (23)	SADS-L/DSM-III Criteria	PSG	BP reported waking rest as particularly useful NP exhibited shorter SOL & REM latency compared to BP. BP demonstrated lower REM density than NP.
Perlmutter et al. (2006)	L	USA	BDI (54)	SCID	PSQI	Sleep duration did not predict changes in mania or depression after 1 month. However, shorter sleep duration predicted more severe depression over 6 months.
Ritter et al. (2012)	S-L	Germany	BP (22) CO (28) HR (9)	SCID	Actigraphy, BIPS-Q Sleep Diary	No group differences in SE, SV or WASO. HR demonstrated greater variability in night time activity compared to CO. BP demonstrated longer sleep duration, SOL & TIB compared to the other groups.
Robillard et al. (2013)	S-L	Australia	BP (29) CO (20) UP (46)	DSM-IV Criteria	Actigraphy, Sleep Diary	Depressed BP & UP exhibited greater WASO & TIB, and poorer SE than CO. The proportion of participants demonstrating a delayed sleep phase was higher in BP than UP.
Salvatore et al. (2008)	S-L	Italy	BDI (36) CO (32)	SCID	Actigraphy, Sleep Diary	CO demonstrated a higher percentage of daytime activity & activity rhythm amplitude compared to BDI. BDI exhibited an advanced acrophase during

Table 1. (continued)

Author (Date)	Design	Location	Participants (N)	Diagnostic Classification	Measure of CR/SR	Key Findings
Shen et al. (2008a)	L	USA	CYC (71)	GBI	SRM	mood episodes and periods of euthymia. ISI was higher during periods of euthymia compared to during mood episodes. Within BDI, no correlation was observed between actigraphy variables and mood status.
Shen et al. (2008b)	L	USA	BDI (149) CYC/NOS (57) CO (208)	GBI/SADS-L	SRM-T	Negative correlation between the number of regular activities performed and depression symptom scores. SRM scores negatively correlated with MV and SDV. BP performed fewer regular activities than CO. Lower SRM-T scores predicted shorter time to onset of mood episodes.
St-Amand et al. (2013)	S-L	USA	BDI (11) BDI (3) CO (13) IP (13)	SCID	Actigraphy, Sleep Diary, ISI, GFI, SRM-5, ESS	BP & IP were less physically active than CO. No group differences in actigraphic SOL, WASO, or TST. IP reported the most severe sleep difficulties followed by BP and then CO. BP reported lower SE, WASO & SOL, & greater sleep duration compared to IP.
Swartz et al. (2005)	I	USA	BDI (58) BDI+BPD (12)	SCID	Impact of IPSRT	25% of the BDI+BPD sample reached stabilisation compared to 74% of the BDI sample. Within the BDI+BPD sample, those who

Table 1. (continued)

Author (Date)	Design	Location	Participants (N)	Diagnostic Classification	Measure of CR/SR	Key Findings
Swartz et al. (2009)	I	USA	BDI (17)	SCID	Impact of IPSRT	reached stabilisation took nearly 3 x as long to do so compared to those in the BDI sample. Significant improvements in manic & depressive symptoms, & overall illness severity, were observed over time. 29% reached full remission of symptoms by visit 20.
Swartz et al. (2012)	I	USA	BDI (25)	SCID	Impact of IPSRT vs Quetiapine	BDI in both treatment conditions exhibited significant improvements in hypomanic and depressive symptoms over time. Treatment satisfaction was high in both conditions.
Sylvia et al. (2009)	I	USA	BDI (64) CYC (37) CO (100)	GBI/SADS-L	SRM-T, LEI	BP demonstrated lower SRM-T scores than CO at all 3 FU points. BP also reported more SRD-E & Sleep Loss events compared to CO at all FU points. SRM-T scores did not predict time to depressive or hypomanic episodes. Those who experienced a depressive episode during the study reported a greater number of SRD-E in the 8 week pre-onset period compared to the 8 week illness-free period.

Table 1. (continued)

Author (Date)	Design	Location	Participants (N)	Diagnostic Classification	Measure of CR/SR	Key Findings
Talbot et al. (2009)	I	USA	BDI (24) BDII (4) CO (28)	SCID	PSG	BP exhibited greater REM density than CO. Both groups demonstrated shorter SOL on sad MI night compared to baseline night. On happy MI night BP demonstrated longer SOL than CO. However self-reported SOL did not differ between the groups.
Talbot et al. (2012)	S-L	USA	BDI (43) BDII (6) CO (52) IP (34)	SCID	Sleep Diary, DSISD	There were no group differences in TST, IIB, BT, WT or GUT. IP & BP demonstrated greater SOL, WASO & TWT compared to CO, & also exhibited poorer SE. IP demonstrated greater SOL & WASO than BP. Compared to BP & IP, CO reported less negative mood during the morning & evening.
Thase et al. (1989)	S-L	USA	BDI (7) BDII (19) CO (26)	SADS-L/ DSM-III Criteria	PSG	Whilst no significant group differences in sleep were observed, BP demonstrated a trend for higher REM sleep compared to CO.
Wu et al. (2009)	I	USA	BP (49)	SCID	Impact of CAT vs IAU	There was a significant reduction in depressive symptom ratings post-treatment in participants who received CAT vs those who received IAU. This was sustained for as long as 7 weeks. Of the 19 participants who responded to CAT, 12 met criteria for remission.

Note. S-L = Semi-longitudinal; L = Longitudinal; I = Intervention; Q = Qualitative; C = Cross-sectional; CO = Control participants; BP = Participants with Bipolar Spectrum Disorder; BDI = Participants with Bipolar I Disorder; BDI+BDP = Participants with Bipolar I Disorder and Borderline Personality Disorder; BDI = Participants with Bipolar II Disorder; BD-NOS = Participants with Bipolar Disorder Not-Otherwise-Specified; UP = Participants with Unipolar Disorder; IP = Participants with Insomnia; HR = Participants at high-risk of bipolar disorder; UR = Participants at high-risk of unipolar disorder; NP = Participants with Narcolepsy; TSD = Total sleep deprivation; NI = Negative Ion Treatment; LT = Light Therapy; CAT = Chronotherapeutic Augmentation Therapy; PSG = Polysomnography; LES = Life Events Scale (Alloy & Clements, 1992); RDC = Research Diagnostic Criteria (Spitzer, Endicott & Robins, 1978); ISI = Insomnia Severity Index (Morin, Belleville, Bélanger et al., 2011); IDI = Insomnia Diagnostic Interview (Harvey et al., 2005); SDQ = Sleep Disturbance Questionnaire (Espie, Brooks & Lindsay, 1989); DBAS = Dysfunctional Beliefs and Attitudes about Sleep Scale (Morin, 1993); BDI-II = Beck Depression Inventory, Second Edition (Beck, Steer & Brown, 1996); DSM-III/ DSM-IV = Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 1980, 1994); MPT = Munich Personality Test (von Zerssen, Pfister & Koeller, 1988); IPSRT = Interpersonal and Social Rhythm Therapy (Frank, Swartz & Kupfer, 2000); BIPS-Q = Bipolar Sleep Questionnaire (Ritter et al., 2012); SRM = Social Rhythm Metric (Monk et al., 1990); SRM-5 = Social Rhythm Metric Short Form (Monk, Frank, Potts & Kupfer, 2002); SRM-T = Trait Social Rhythm Metric (Shen, Sylvia, Alloy et al., 2008a); GBI = General Behaviour Inventory (Depue, Krauss, Spoont & Arbi, 1989); GITI = Glasgow Intrusive Thoughts Inventory (Harvey & Espie, 2004); ESS = Epworth Sleepiness Scale (Johns, 1991); LEDS = Bedford College Life Events and Difficulty Schedule (Brown & Harris, 1978); LEI = Life Events Interview (Alloy & Abramson, 1999); SRD-E = Social Rhythm Disrupting-Events; DSISD = Duke Structured Interview for Sleep Disorders (Edinger, Bonnet, Bootzin et al., 2004); ERC = Early Recognition Centre; EIS = Early Intervention Services; PSQI = Pittsburgh Sleep Quality Inventory (Buysse, Reynolds III, Monk et al., 1989); ADE = Affective Disorder Evaluation (Sachs, Thase, Otto et al., 2003); CIDI-Auto = Composite International Diagnostic Interview (Robins, Wing, Wittchen et al., 1988); CMF = Clinical Monitoring Form (Sachs, Guille & McMurrich, 2002); HPS = Hypomanic Personality Scale (Eckblad & Chapman, 1986); MINI = Mini-International Neuropsychiatric Interview (Sheehan, Lecrubier, Sheehan et al., 1998); SADS-L = Schedule for Affective Disorders and Schizophrenia—Lifetime version (Endicott & Spitzer, 1978); SCID = Structured Clinical Interview for DSM-IV Disorders (First, Gibbon, Spitzer et al., 1997); MI = Mood Induction; CC = Collaborative Care; TAU = Treatment As Usual; FU = Follow-Up; RA = Relative Amplitude; IV = Intradaily Variability; IS = Interdaily Stability; VI = Vulnerability Index; SOL = Sleep Onset Latency; TIB = Time In Bed; SE = Sleep Efficiency; TWT = Total Wake Time; TST = Total Sleep Time; BT = Bed Time; WT = Wake Time; GUT = Get-Up Time; WASO = Wake After Sleep Onset; SDV = Sleep Duration Variability; MV = Mood Variability; NA = Negative Affect.

2.4.2 Methodological Limitations of Studies

An overview of the main methodological limitations of included studies is presented in Table 2. Whilst groups were matched on age and gender in almost all cases, a gender bias was evident throughout with a tendency for more female than male participants. As existing evidence suggests that bipolar disorder affects males and females equally (Hendrick, Altshuler, Gitlin et al., 2000; Weissman, Leaf, Tischler et al., 1988), this somewhat limits the generalizability of the findings. Although a number of studies reported the employment status and ethnicity of the study groups, comparatively few were able to match groups on these two factors (see Table 2). Furthermore, very few studies considered group differences in marital status and education. This is a notable limitation as research has shown that such factors are not only significantly associated with clinical status (Wingo, Baldessarini, Holtzheimer & Harvey, 2010; Bauer, Glenn, Rasgon et al., 2011), but are also linked to social rhythm regularity (Sylvia, Alloy, Hafner et al., 2009).

Studies of non-clinical individuals at-risk for developing bipolar disorder, tended to use student samples (see Table 2). On the one hand, student populations are highly appropriate for identifying high-risk individuals due to similarities between the average age of undergraduate populations and the average age of onset in bipolar disorder (Merikangas, Akiskal, Angst et al., 2007). Furthermore, undergraduate university students are highly accessible to academic researchers and are therefore an ideal group to recruit in practical terms. Conversely, recent statistics indicate that 57.6% of UK higher education students are female, with 81.1% of students originating from white ethnic backgrounds (Higher Education Statistics Agency Limited, 2013). Therefore it is unclear exactly how representative undergraduate student samples are of the general high-risk population, particularly in light of evidence demonstrating a positive relationship between socioeconomic status and mental well-being in both student samples and bipolar populations (Bauer, Glenn, Rasgon et al., 2011; Ibrahim, Kelly & Glazebrook, 2013).

Four studies assessed sleep via laboratory-based PSG (see Table 1). Whilst this approach enables sleep to be assessed under controlled conditions, reducing the potential impact of extraneous variables (e.g. being disturbed by a bed partner), there is conversely a reduction in ecological validity. Therefore the results obtained by these studies may not be representative of a natural night's sleep. Although PSG is commonly regarded as the “gold standard” in obtaining sleep estimates, actigraphy estimates show very good agreement (Ancoli-Israel, Copton, Klauber, et al., 1997; Kushida, Chang, Gadkary et al., 2001). Therefore findings reported by actigraphy studies are not necessarily less accurate, and are likely to be more ecologically valid.

Table 2. Sources of bias in included studies

Author (Date)	Power	Sample	SD Variables Controlled For	Gender Bias	Monitoring Period	Follow-Up
Ankers & Jones (2009)	Unknown	Students	Age Gender Employment	HR: Female > Male CO: Female > Male	7 days	N/A
Bauer et al. (2006)	Unknown	Outpatients	N/A	Female > Male	≥100 days	N/A
Bauer et al. (2009)	Unknown	Outpatients	N/A	Female > Male	≥100 days	N/A
Benedetti et al. (2007)	Unknown	Inpatients	Age Education Age at onset No. of prev. episodes	Responders: Female > Male Non-responders: Male > Female	7 days	N/A
Boland et al. (2012)	Unknown*	Students	Age Gender Ethnicity	BP: Female > Male CO: Female > Male	N/A	At 4 and 8 months
Bullock et al. (2011)	Unknown	BDI= Outpatients HR & LR= Students	Age	BDI: Female > Male HR: Female > Male LR: Female > Male	7 days	N/A
Bullock & Murray (2013)	Unknown	Students	Age Gender	HR: Female > Male LR: Female > Male	7 days	N/A
Colombo et al. (1999)	Unknown	Inpatients	N/A	Female > Male	N/A	Up to 1 month

Table 2. (continued)

Author (Date)	Power	Sample	SD Variables Controlled For	Gender Bias	Monitoring Period	Follow-Up
Dauphinais et al. (2012)	Not calculated**	Outpatients	Age Gender	LT: Female > Male NI: Female > Male	N/A	8 weeks
Eidelman et al. (2010)	Unknown	BP= Outpatients CO= Volunteers	Age Gender Ethnicity Education Employment Marital Status	BP: Female > Male CO: Female > Male	1 night	3 months
Fosson et al. (1998)	Unknown	Inpatients	Age Gender	BP: Male > Female UP: Male > Female	2-3 nights	N/A
Gershon et al. (2012)	Unknown	Volunteers	Age Gender Employment Income	BP: Female > Male CO: Female > Male	8 weeks	N/A
Gruber et al. (2009)	Unknown	Outpatients	Age Ethnicity	Female > Male	N/A	N/A
Gruber et al. (2011)	Unknown	Outpatients	Age	Female > Male	N/A	N/A
Harvey et al. (2005)	Unknown	BDI: Outpatients IP: Outpatients CO: Volunteers	Age Gender Employment	BDI: Equal IP: Female > Male CO: Female > Male	8 days	N/A

Table 2. (continued)

Author (Date)	Power	Sample	SD Variables Controlled For	Gender Bias	Monitoring Period	Follow-Up
Hudson et al. (1992)	Unknown	BP: Inpatients UP: Inpatients CO: Volunteers	Age	BP: Male > Female UP: Female > Male CO: Female > Male	N/A	N/A
Indic et al. (2011)	Unknown	Study 1- Volunteers	Age Gender	Study 1- LR: Female > Male HR: Female > Male	Study 1: 7 days	N/A
		Study 2- Outpatients/Volunteers		Study 2- BP: Male > Female CO: Male > Female	Study 2: 7 days	N/A
		Study 3- Inpatients		Study 3- Female > Male	Study 3: 3 days	N/A
Indic et al. (2012)	.77	Outpatients	Age Gender	BDI: Female > Male BDII: Female > Male UP: Female > Male	3 days	N/A
Jones et al. (2005)	Unknown	BDI: Outpatients CO: Volunteers	Age Gender	BDI: Female > Male CO: Female > Male	7 days	N/A
Jones et al. (2006)	Unknown	BP: Outpatients CO: Volunteers	Age Gender Education	BP: Female > Male CO: Female > Male	7 days	N/A
Kaplan et al. (2011)	Unknown	Volunteers	Age Gender Ethnicity Employment Income	BP: Female > Male CO: Female > Male	7 days	6 months

Table 2. (continued)

Author (Date)	Power	Sample	SD Variables Controlled For	Gender Bias	Monitoring Period	Follow-Up
Marital Status						
Kuhs & Reschke (1992)	Unknown	Inpatients	Age Gender	BP: Equal UP: Female > Male	2 days	N/A
Liebenluft et al. (1996)	Unknown	Outpatients	N/A	Female > Male	18 months	N/A
Malkoff-Schwartz et al. (1998)	Unknown	Volunteers	N/A	Female > Male	N/A	N/A
Malkoff-Schwartz et al. (2000)	Unknown	Volunteers	Age No. of prev. episodes	BP: Female > Male UP: Female > Male	N/A	N/A
Meyer & Maier (2006)	Unknown	Students	Age Gender	HR: Female > Male UR: Female > Male CO: Female > Male	4 weeks	N/A
Miklowitz et al. (2007)	Unknown***	Outpatients	Age Gender Ethnicity Education Income Marital Status	Female > Male	N/A	3 months
Millar et al. (2004)	Unknown	BDI: Outpatients CO: Volunteers	Age Gender Marital Status	BDI: Female > Male CO: Female > Male	5 days	N/A

Table 2. (continued)

Author (Date)	Power	Sample	SD Variables Controlled For	Gender Bias	Monitoring Period	Follow-Up
Murray et al. (2011)	Unknown	Volunteers	N/A	Female > Male	N/A	N/A
Nofzinger et al. (1991)	Unknown	Outpatients	Age	BP: Female > Male NP: Female > Male	2 nights	N/A
Pedman et al. (2006)	Unknown	Outpatients/Inpatients	N/A	Female > Male	N/A	Monthly for 6 months
Ritter et al. (2012)	Unknown	BP: Outpatients CO: Volunteers HR: ERC	Education Employment	BP: Male > Female CO: Male > Female HR: Male > Female	6 days	N/A
Robillard et al. (2013)	Unknown	BP & UP: EIS CO: Volunteers	Age	BP: Female > Male CO: Female > Male UP: Female > Male	7 days	N/A
Salvatore et al. (2008)	Unknown	BDI: Inpatients CO: Volunteers	Age Gender Employment	BDI: Female > Male CO: Female > Male	3 days	N/A
Shen et al. (2008a)	Unknown	Students	Age Gender Ethnicity Parental Education	Female > Male	6 weeks	N/A
Shen et al. (2008b)	Unknown	Students	Age Gender Ethnicity	BP: Female > Male CO: Female > Male	N/A	33 months (average)

Table 2. (continued)

Author (Date)	Power	Sample	SD Variables Controlled For	Gender Bias	Monitoring Period	Follow-Up
St-Amand et al. (2013)	Unknown	BP: Outpatients CO & IP: Volunteers	Age Gender Education Employment Marital Status	BP: Equal CO: Male > Female IP: Female > Male	14 days	N/A
Swartz et al. (2005)	Unknown	Inpatients	Gender Education	BDI: Female > Male BDI/BPD: Female > Male	N/A	Up to 145 weeks
Swartz et al. (2009)	Unknown	Outpatients	Age Gender Education Employment Marital Status	Responders: Female > Male Non-responders: Equal	N/A	8 weeks
Swartz et al. (2012)	Unknown	Outpatients	Age Gender Ethnicity Education Employment Marital Status	IPSRT: Equal Quetiapine: Female > Male	N/A	12 weeks
Sylvia et al. (2009)	Unknown	Students	Age Gender Ethnicity	BDI: Female > Male CYC: Female > Male CO: Female > Male	N/A	Up to 12 months
Talbot et al. (2009)	Unknown	Volunteers	Age Gender	BP: Female > Male CO: Female > Male	3 nights (1 month apart)	N/A

Table 2. (continued)

Author (Date)	Power	Sample	SD Variables Controlled For	Gender Bias	Monitoring Period	Follow-Up
			Ethnicity Education Employment Marital Status			
Talbot et al. (2012)	Unknown	Volunteers	Gender Ethnicity Education Employment Income Marital Status	BP: Female > Male CO: Female > Male IP: Female > Male	7 days	N/A
Thase et al. (1989)	Unknown	BP: Outpatients CO: Volunteers	Age Gender	BP: Female > Male CO: Female > Male	2 nights	N/A
Wu et al. (2009)	Unknown	Outpatients	Age Gender	CAT: Male > Female TAU: Female > Male	N/A	7 weeks

Note. ERC= Early Recognition Centre; EIS= Early Intervention Service.

* Although details of power analysis were not reported, authors state that the study was adequately powered.

** Authors argue power analysis unfeasible due to lack of existing data to calculate effect sizes.

*** Underpowered to detect small effect size differences between each of the conditions (i.e. would require sample size of 445 per group)

2.4.3 Sleep

2.4.3.1 *Do non-clinical individuals at high-risk for bipolar disorder exhibit sleep disturbance?*

Four studies investigated sleep patterns in high-risk and control samples, three of which used actigraphy (Ankers & Jones, 2009; Ritter, Marx, Lewtschenko et al., 2012; Bullock & Murray, 2013), while one used the SRM (Meyer & Maier, 2006). High-risk individuals demonstrated significantly greater variability in bed-times and get-up times (Meyer & Maier, 2006; Ankers & Jones, 2009), but not sleep efficiency, compared to controls (Ankers & Jones, 2009; Ritter et al., 2012; Bullock & Murray, 2013). Sleep efficiency represents the percentage of time an individual is actually asleep for whilst in bed, and is therefore often used as a measure of sleep quality.

Evidence relating to sleep duration, and also sleep onset latency (SOL), in high-risk samples is inconsistent. Most studies failed to identify significant differences between high-risk and control participants (Meyer & Maier, 2006; Ritter et al., 2012; Bullock & Murray, 2013). However one study observed significantly shorter sleep duration in high-risk participants compared to controls, in addition to significantly longer SOL (Ankers & Jones, 2009). Possible reasons for the contradictory findings are unclear as Ankers and Jones (2009) classified high-risk participants in the same manner as Meyer and Maier (2006), and employed similar methodology to Bullock and Murray (2013).

Ankers and Jones (2009) also reported greater variability in sleep duration and sleep efficiency in high-risk individuals compared to controls. Only one other study examined group differences in sleep variability (Ritter et al., 2012), reporting similar levels in both groups. Due to the nature of the high-risk sample studied by Ritter et al. (2012; see Table 2) it is possible that these participants were already aware of the importance of maintaining a stable sleep pattern and may have even received support or guidance on this issue, thus displaying greater stability in their sleep patterns compared to the student population studied

by Ankers and Jones (2009). It is also possible that the former study was under-powered due to the size of the high-risk sample ($n < 10$). However, as Ritter et al. (2012) did not report standard deviations for sleep efficiency or sleep duration in either sample, it was not possible to compare effect sizes between the two studies.

2.4.3.2 Do euthymic bipolar individuals exhibit sleep disturbance?

Eight studies compared the sleep profiles of euthymic bipolar individuals with healthy controls (Gershon, Thompson, Eidelman et al., 2012; Harvey et al., 2005; Jones, Hare & Evershed, 2005; Millar, Espie & Scott, 2004; Ritter et al., 2012; Salvatore, Ghidini, Zita et al., 2008; St-Amand et al., 2013; Talbot, Stone, Gruber et al., 2012). Three studies reported statistically significant group differences in sleep duration when measured via actigraphy, with euthymic bipolar individuals sleeping longer than controls (Harvey et al., 2005; Ritter et al., 2012; Salvatore et al., 2008). Four similar studies reported statistically non-significant group differences in actigraphically-measured sleep duration (Gershon et al., 2012; Jones et al., 2005; Millar et al., 2004; St-Amand et al., 2013), although the direction of the differences demonstrated longer sleep duration in the bipolar groups as compared to the controls, raising the possibility that these studies were under-powered.

Studies which assessed self-reported estimates of sleep duration tended to report statistically non-significant group differences (Gershon et al., 2012; Harvey et al., 2005; St-Amand et al., 2013; Talbot et al., 2012). However Millar et al. (2004) reported significantly longer sleep durations in bipolar participants compared to healthy controls. It is possible that, had Millar et al. (2004) measured subjective sleep duration over a longer time period (see Table 2), the authors would have obtained results consistent with later investigations.

Non-significant differences between euthymic bipolar individuals and healthy controls in actigraphically-measured SOL were reported by the majority of studies (Gershon et al., 2012; Harvey et al., 2005; Jones et al., 2005; Millar et al., 2004; St-Amand et al., 2013).

However, Ritter et al. (2012) reported significantly longer SOL in the bipolar group as compared to the control participants. Of the six studies to assess self-reported SOL, four reported significantly longer estimates in euthymic bipolar participants (Harvey et al., 2005; Millar et al., 2004; Ritter et al., 2012; Talbot et al., 2012). Examination of the effect sizes across studies suggests that the two non-significant investigations (Gershon et al., 2012; St-Amand et al., 2013) may have been under-powered to detect statistically significant differences. However, it was not possible to compute the effect size of the findings reported by Ritter and colleagues (2012) due to an absence of reported means and standard deviations.

Studies which assessed sleep efficiency using actigraphy, consistently reported no difference between euthymic bipolar individuals and controls (Gershon et al., 2012; Jones et al., 2005; Millar et al., 2004; Ritter et al., 2012; St-Amand et al., 2013). However, subjective findings were mixed with two studies reporting significantly poorer sleep efficiency in euthymic bipolar individuals compared to controls (Harvey et al., 2005; Talbot et al., 2012), and three reporting non-significant group differences (Gershon et al., 2012; Millar et al., 2004; St-Amand et al., 2013). Examination of effect sizes indicates that the latter studies may have lacked statistical power in comparison to the investigations conducted by Harvey et al. (2005) and Talbot et al. (2012).

Evidence based on actigraphy indicates a lack of significant differences in sleep duration variability between euthymic bipolar and control individuals (Gershon et al., 2012; Jones et al., 2005; Ritter et al., 2012). However, Millar et al. (2004) reported significantly greater sleep duration variability in euthymic bipolar individuals. Unlike the other three studies, Millar et al. (2004) did not attempt to correct for multiple testing which may explain the contradictory results. This idea is strengthened by the fact that Millar et al. (2004) reported higher subjective sleep duration variability in contrast to Gershon and colleagues (2012), who found no difference when a corrected significance level was applied (i.e. $p \leq 0.00625$).

Non-significant differences in actigraphically-measured sleep efficiency variability between euthymic bipolar and control participants, were reported across all studies (Gershon et al., 2012; Jones et al., 2005; Millar et al., 2004; Ritter et al., 2012). Examination of the non-significant results did not indicate any consistent trends in the data. The two studies which considered sleep efficiency variability based on subjective sleep data, both observed significantly greater variability in the bipolar group as opposed to the control group (Millar et al., 2004; Gershon et al., 2012). Viewed together, the findings suggest that during periods of euthymia, individuals with bipolar disorder may misperceive the amount of sleep they get each night, and/or the amount of time they spend in bed. Inspection of the data reported by Gershon et al. (2012) supports this idea, with subjective estimates of the variability of total sleep time far exceeding objective estimates in the bipolar sample. Furthermore, Harvey et al. (2005) reported higher scores on the DBAS (Morin, 1993), a measure of dysfunctional attitudes and beliefs about sleep, in her euthymic bipolar sample compared to a healthy control group, indicating that even during euthymia bipolar individuals possess maladaptive beliefs about sleep.

Studies comparing bipolar and control individuals on actigraphically-measured SOL variability, converge on the lack of significant group differences (Gershon et al., 2012; Jones et al., 2005; Millar et al., 2004; Ritter et al., 2012). However, an overall non-significant trend for greater variability in euthymic bipolar individuals was demonstrated. Of the two studies to report findings on self-reported SOL variability, Millar and colleagues (2004) observed significantly greater variability in the bipolar group as opposed to the control group, whilst Gershon et al. (2012) reported non-significant results in the same direction.

Only one study considered REM sleep during periods of euthymia in comparison to non-clinical controls (Eidelman et al., 2010). No significant group differences were observed in NREM sleep, REM latency, or the percentage of time spent in REM sleep. However, euthymic bipolar individuals did demonstrate significantly higher REM density than control participants.

Studies which compared euthymic bipolar individuals and individuals with insomnia, have reported inconsistent findings (Harvey et al., 2005; St-Amand et al., 2013; Talbot et al., 2012). Two studies assessed sleep parameters using actigraphy, both reporting non-significant differences in the amount of time spent awake during the sleep period (i.e. wake after sleep onset or WASO) and SOL between insomnia and bipolar individuals (Harvey et al., 2005; St-Amand et al., 2013). However, the studies differ with regard to self-reported estimates of these concepts. St-Amand et al. (2013) reported significantly shorter subjective SOL and WASO in the bipolar group as compared to the insomnia group, corroborating findings reported by Talbot et al. (2012). Although Harvey et al. (2005) reported non-significant differences in subjective WASO, the data reflect a trend in the same direction. Therefore the difference in findings may relate to differences in the significance level applied by Harvey et al. (2005) in comparison to the other studies (i.e $p < 0.02$ vs $p \leq 0.05$). Results regarding subjective SOL however reflect a non-significant trend in the opposite direction, such that the bipolar participants reported longer SOL than the insomnia participants (Harvey et al., 2005).

Reports of objectively measured total sleep time (TST) in bipolar and insomnia populations are inconsistent. Whereas Harvey et al. (2005) observed longer periods of TST in the bipolar group, St-Amand et al. (2013) did not observe significant group differences. St-Amand et al. (2013) also reported longer subjective TST and higher subjective sleep efficiency in euthymic bipolar individuals as compared to individuals with insomnia, whereas both Harvey et al. (2005) and Talbot et al. (2012) did not observe significant differences between the groups. Although St-Amand and colleagues (2013) monitored participants over the longest period, strengthening the reliability of the results, the results reported by the two earlier investigations are based upon larger samples, thus reducing the likelihood of Type II error (see Table 1).

2.4.3.3 Is there a relationship between sleep disturbance and mood in euthymic bipolar populations?

Two studies observed negative associations between sleep duration and symptoms of mania in euthymic bipolar individuals (Bauer, Grof, Rasgon, Bschor et al., 2006; Gruber, Miklowitz, Harvey et al., 2011). Bauer et al. (2006) also observed a positive relationship between longer self-reported sleep duration and depressed mood the following day, later reporting that sleep duration was more strongly associated with an oncoming mood change than either sleep onset or sleep offset (Bauer, Glenn, Grof et al., 2009). Similarly, Kaplan, Gruber, Eidelman et al. (2011) found hypersomnia to be positively associated with the severity of depressive symptoms 6 months later.

Talbot et al. (2012) assessed bi-directional relationships between self-reported sleep and mood in a euthymic bipolar sample. The authors reported that higher ‘total wake time’ (TWT; i.e., total time spent awake during the sleep period) significantly predicted lower positive mood and higher negative mood on the subsequent morning. Additionally, increases in evening negative mood were predictive of increases in TWT on the same night.

Gershon and colleagues (2012) reported a positive correlation between actigraphically-measured SOL and negative mood over 8 weeks in both euthymic bipolar and control participants, suggesting that the longer it takes someone to fall asleep, the more negative their mood will be regardless of their diagnostic status. Conversely, Jones et al. (2005) failed to observe significant relationships between mood symptoms and actigraphically-measured SOL. However, it is possible that the relationship between SOL and negative mood represents a small effect, therefore the shorter monitoring period employed in the latter study (see Table 2) may underlie the conflicting findings.

Talbot, Hairston, Eidelman et al. (2009) reported a significant decrease in self-reported SOL following a negative mood induction compared to a neutral mood induction, in both euthymic bipolar and control participants. This suggests that individuals fall asleep quicker

when experiencing a negative mood compared to a neutral mood, which is at odds with the findings described above. However, as the results of Talbot et al. (2009) reflect the relationship between SOL and induced negative mood, whereas the findings reported by Gershon et al. (2012) reflect the relationship between SOL and self-reported negative mood, direct comparison between the two studies may be inappropriate. It is also important to note that a substantial proportion of the participants studied by Talbot et al. (2009) did not reach the specified threshold in the negative mood induction condition, and it is unclear how long the effects of the mood induction lasted for after the procedure had ended and the participants had gone to bed.

In terms of the relationship between REM sleep and mood, Talbot et al. (2009) reported an increase in REM density following negative mood induction in both euthymic bipolar and control participants. Eidelman et al. (2010) did not observe significant relationships between REM density and depressive or manic symptoms at baseline, although the authors did observe a positive correlation between baseline REM density and depressive symptoms at 3 month follow-up. Again, as induced negative mood is not necessarily equivalent to subsyndromal symptoms of depression, it is difficult to draw direct comparison between the two studies.

2.4.3.4 Is there a relationship between sleep disturbance and clinical status in bipolar disorder?

Ten studies monitored sleep during periods of illness and euthymia in bipolar populations (Fossion, Staner, Dramaix et al., 1998; Gruber, Harvey, Wang et al., 2009; Hudson, Lipinski, Keck et al., 1992; Liebenluft, Albert, Rosenthal et al., 1996; Nofzinger, Thase, Reynolds III et al., 1991; Perlman, Johnson & Mellman, 2006; Robillard, Naismith, Rogers et al., 2013; Salvatore et al., 2008, Shen et al., 2008a; Thase, Himmelhoch, Mallinger et al., 1989). In comparison to non-clinical controls, bipolar individuals were found to demonstrate reduced sleep efficiency during both manic and depressive episodes (Hudson et

al., 1992; Robillard et al., 2013). One study also observed shorter REM latency and higher REM density in bipolar individuals experiencing a manic episode compared to non-clinical controls (Hudson et al., 1992). Significant group differences in REM sleep were not observed in depressed bipolar individuals compared to controls however (Thase et al., 1989).

Gruber et al. (2009) categorised individuals with bipolar disorder as short sleepers (i.e. < 6 hours sleep per night), normal sleepers (i.e. 6.5 to 8.5 hours sleep per night) or long sleepers (i.e. \geq 9 hours sleep per night) based upon self-reported sleep duration. A greater proportion of individuals from within the short (n=641) and long (n=467) sleeper groups were depressed compared to the normal sleepers (n=760). Of the normal sleeper group, the majority were euthymic (51.7%). Short sleepers demonstrated longer illness duration and more severe symptoms of mania, depression, and anxiety compared to the other two groups. Of the short sleeper group, 23.7% exhibited elevated mood in comparison to 9.1% and 6.9% of the normal and long sleeper groups respectively. Furthermore, Liebenluft et al. (1996) found that longer sleep duration was associated with a reduced probability of experiencing symptoms of mania and hypomania the following day.

Three studies failed to identify a significant relationship between sleep duration and mania/hypomania (Perlman et al., 2006; Salvatore et al., 2008; Shen et al., 2008a), two of which also reported non-significant relationships between sleep duration and depression (Perlman et al., 2006; Shen et al., 2008a). However, Perlman and colleagues (2006) did observe a significant correlation at 6 months, such that shorter sleep duration predicted more severe depressive symptoms. In light of the results reported by Gruber et al. (2009), it is possible that the inconsistency in findings reflects the fact that having both too little and too much sleep is associated with illness severity in bipolar disorder.

In a qualitative study of high functioning individuals with bipolar disorder, sufficient and regular sleep was highlighted as a key strategy for preventing relapse (Murray, Suto, Hole et al., 2011). This finding compliments those reported by Gruber et al. (2009), who found that

both long and short sleepers demonstrated greater depressive symptom severity compared to normal sleepers, with long sleepers exhibiting significantly greater sleep variability. Similarly Shen et al. (2008a) found that greater variability in sleep duration over a 2 week period positively correlated with higher depressive symptom scores in individuals meeting criteria for cyclothymia. However, sleep duration variability did not significantly correlate with symptoms of hypomania.

Few studies assessed sleep in bipolar disorder compared to other severe conditions. Two studies compared sleep in depressed bipolar patients and depressed unipolar patients (Fossion et al., 1998; Robillard et al., 2013). Fossion et al. (1998) did not observe significant differences between the two groups on any sleep variable using PSG. Similarly Robillard et al. (2013) did not observe significant group differences in WASO or TST based on seven days of actigraphy recording. However, when focusing purely on the weekend period, bipolar participants demonstrated significantly longer TST compared to the unipolar participants (Robillard et al., 2013). Robillard et al. (2013) also found that a greater proportion of the bipolar patients exhibited a delayed sleep phase (i.e. fell asleep later and woke up later) compared to the unipolar participants, and generally spent more time in bed. Nofzinger et al. (1991) investigated the sleep profiles of depressed individuals with bipolar disorder, in comparison to individuals with narcolepsy, reporting shorter REM latency, lower REM density and longer SOL in the bipolar group. However, as these findings are based on a single study, they must be viewed with caution.

2.4.4 Activity

2.4.4.1 Do non-clinical individuals at high-risk for bipolar disorder exhibit activity rhythm disturbance?

Four studies examined activity rhythms in individuals deemed to be at high-risk for developing bipolar disorder (Ankers & Jones, 2009; Indic, Salvatore, Maggini et al., 2011;

Ritter et al., 2012; Bullock & Murray, 2013). Activity patterns are often measured in terms of interdaily stability (IS; the degree of resemblance between activity patterns on individual days), intradaily variability (IV; the extent of fragmentation), and relative amplitude (RA; the amplitude of an activity rhythm).

Of the three studies to examine between group differences in IS, IV, and average levels of activity, none observed significant differences between control participants and individuals at risk (Ankers & Jones, 2009; Ritter et al., 2012; Bullock & Murray, 2013). However, two studies did observe significantly lower RA in high-risk individuals (Ankers & Jones, 2009; Bullock & Murray, 2013). Bullock and Murray (2013) investigated this finding further by comparing individuals with and without a history of previous major depressive episode (MDE), who also scored highly on the GBI (Depue et al., 1989). Overall, those with a history of previous MDE, exhibited significantly lower RA compared to those without. Additionally, high GBI scorers with a past history of MDE, demonstrated significantly lower RA compared to the low GBI group as a whole (i.e. regardless of past MDE status). High GBI scorers without a past history of MDE however, did not differ significantly from the low GBI scorers as a whole. Viewed together, the results indicate an important relationship between RA and previous MDE in individuals at high-behavioural risk for bipolar disorder.

Indic and colleagues (2011; 2012) examined the amplitudes of activity rhythms over 2 hour intervals to produce the ‘vulnerability index’, or VI, which represents the scale-invariance of physical activity patterns. Scale invariance refers to the observation that certain features of complex biological systems look the same when viewed on both small and large scales (Gisiger, 2001). It is proposed that the suprachiasmatic nucleus (SCN), which is thought to regulate circadian rhythms, underlies the scale-invariant properties of human activity patterns (Hu, Scheer, Ivanov et al., 2007). Indic et al. (2011) investigated the ability of the VI to distinguish between individuals at varying levels of risk for bipolar disorder. The authors found that the VI score increased with risk, such that controls exhibited the lowest VI, followed by high-risk participants, followed by individuals with diagnosed bipolar disorder.

2.4.4.2 Do euthymic bipolar individuals exhibit activity rhythm disturbance?

Four studies explored the nature of physical activity rhythms in euthymic bipolar populations (Harvey et al., 2005; Jones et al., 2005; Salvatore et al., 2008; Indic et al., 2011). Two studies found that euthymic bipolar individuals did not differ significantly from healthy controls in terms of RA (Jones et al., 2005; Salvatore et al., 2008). However, a later study by Indic and colleagues (2011) reported significant differences between these two populations when amplitude was considered over 2 hour intervals represented by the VI as described above. Indic et al. (2011) found the VI was able to distinguish between individuals with and without bipolar disorder. Interestingly, Jones et al. (2005) found that IV significantly predicted group membership in bipolar and control participants, such that individuals with bipolar disorder exhibited a much more disjointed activity pattern compared to controls. Studies also reported lower activity levels in euthymic bipolar individuals as opposed to controls (Harvey et al., 2005; Jones et al., 2005; Salvatore et al., 2008).

2.4.4.3 Is there a relationship between activity rhythm disturbance and mood in bipolar disorder?

Activity rhythms were not found to correlate significantly with affective symptoms during periods of euthymia or illness (Jones et al., 2005 and Salvatore et al., 2008 respectively). Whilst Indic et al. (2011) reported similar findings regarding depressive symptoms, the authors found that both self-rated, and clinician-rated symptoms of mania, were positively associated with VI score. Furthermore, Benedetti, Dallaspazia, Fulgosi et al. (2007) found that depressed individuals who demonstrated a 50 percent reduction in depressive symptom scores in response to chronotherapy, also exhibited significant increases in activity levels post treatment.

Mixed and manic episodes were associated with higher night time activity and lower RA in comparison to periods of euthymia (Salvatore et al., 2008). Bipolar participants

experiencing mixed or manic states also demonstrated lower daytime activity and lower RA compared to controls. Indic et al. (2011) observed increasing VI scores in major depression, mild depression, mild mixed states, hypomania, mixed states and mania respectively. The research team subsequently reported evidence of higher VI scores in depressed individuals with Bipolar I disorder as opposed to Bipolar II disorder (Indic et al., 2012), and were able to distinguish between depressed bipolar and depressed unipolar participants based on the VI. This is a noteworthy finding, as earlier studies failed to observe significant differences in the activity rhythms of depressed bipolar versus depressed unipolar individuals (Kuhs & Reschke, 1992).

2.4.5 Social Rhythms

2.4.5.1 Do non-clinical individuals at high-risk for bipolar disorder exhibit low social rhythm regularity?

Two studies explored social rhythm regularity in individuals considered to be at high behavioural risk for developing bipolar disorder (Meyer & Maier, 2006; Bullock, Judd & Murray, 2011). Both studies observed lower social rhythm regularity in high-risk individuals compared to controls. Meyer and Maier (2006) also examined social rhythms in individuals deemed at risk for unipolar disorder, observing very similar social rhythm regularity scores to the controls. Bullock et al. (2011) found that neither the high-risk, nor control participants, differed significantly from those with a clinical diagnosis of bipolar disorder in terms of social rhythm regularity. However, as the authors point out, the use of the SRM-5 over such a short time frame (see Table 1) has not yet been validated, which raises concerns regarding the reliability of the findings.

2.4.5.2 *Do euthymic bipolar individuals exhibit low social rhythm regularity?*

Seven studies compared the social rhythm regularity of euthymic bipolar individuals, to that of non-clinical controls (Jones et al., 2005; Jones, Tai, Evershed et al., 2006; Bullock et al., 2011; Shen et al., 2008b; Sylvia et al., 2009; Boland, Bender, Alloy et al., 2012; St-Amand et al., 2013), four of which reported lower social rhythm regularity in the bipolar samples (Shen et al., 2008b; Sylvia et al., 2009; Boland et al., 2012; St-Amand et al., 2013). Three studies did not find significant differences in social rhythm regularity between the two populations (Jones et al., 2005; 2006; Bullock et al., 2011), however inspection of effect sizes suggests that the non-significant studies may have been under-powered.

Two studies reported findings relating to the average frequency with which regular activities were performed by bipolar and control participants (Jones et al., 2006; Shen et al., 2008a). Whilst Shen et al. (2008b) reported similar average frequency scores between the two groups, Jones et al. (2006) found that bipolar participants demonstrated a much lower average frequency in comparison to controls. However, differences in the measure of social rhythm regularity employed in each study (see Table 1), indicates that the findings may reflect differences in state versus trait-like social rhythm regularity.

In an effort to test the principles of the social zeitgeber theory, two studies explored the relationship between social rhythm regularity and social rhythm-disrupting events (i.e. SRD events; Sylvia et al., 2009; Boland et al., 2012). SRD events refer to events associated with disruptions to the sleep-wake cycle, such as becoming unemployed or travelling overseas (Malkoff-Schwartz, Frank, Anderson et al., 1998). In support of the social zeitgeber hypothesis, both studies found that such events were more frequently experienced by individuals with bipolar disorder in comparison to controls (Sylvia et al., 2009; Boland et al., 2012). A similar pattern of findings was also observed in relation to 'sleep loss' events (i.e. events associated with at least 1 hour of reduced sleep). Interestingly however, these studies failed to observe significant predictive relationships between the number, or type of, life

events experienced, and trait-level social rhythm regularity (Sylvia et al., 2009; Boland et al., 2012).

2.4.5.3 Is there a relationship between social rhythm regularity and mood in bipolar disorder?

One study assessed relationships between SRD events and subsyndromal symptoms in euthymic bipolar individuals (Sylvia et al., 2009). Participants reported significantly greater symptoms of depression following an SRD event compared to the period before such an event had occurred. Relationships between SRD events and hypomanic symptoms were not significant, however. Mixed results were reported regarding the longitudinal relationship between social rhythm regularity and depression, with lower regularity scores predicting greater symptoms of depression at some follow-up points but not others (Sylvia et al., 2009). A more consistent pattern of results was observed regarding sleep loss events however, with an increase in such events predicting increases in depressive symptoms at 8 and 12 months. Sleep loss events significantly predicted hypomanic symptoms at 12 months but not 8 months (Sylvia et al., 2009), highlighting the need for further investigation into the relationship between sleep loss events and mood symptoms during euthymia.

One study reported a significant cross-sectional relationship between social rhythm regularity and symptoms of depression during cyclothymia, such that individuals who performed a greater number of regular activities also exhibited less severe symptoms of depression over a 2 week period (Shen et al., 2008a). However, changes in social rhythm regularity did not correspond to changes in depressive symptom scores over a 4-week period. Social rhythm regularity also did not significantly predict time to manic, hypomanic or depressive episode onset (Shen et al., 2008b; Sylvia et al., 2009). However, significant findings were reported regarding relationships between social rhythm regularity and type of episode. For example, Sylvia et al. (2009) found that depressive episodes tended to be

preceded by a significantly greater number of SRD events than hypomanic episodes, and Malkoff-Schwartz et al. (1998; Malkoff-Schwartz, Frank, Anderson et al., 2000) reported that SRD events were more closely linked to the onset of manic episodes than depressive episodes.

2.4.6 Interventions

2.4.6.1 Are chronotherapeutic interventions effective in alleviating symptoms of bipolar depression?

Chronotherapeutic interventions refer to treatments which target circadian rhythms such as light therapy (LT) or total sleep deprivation (TSD; Germain & Kupfer, 2008). LT involves exposure to a device which emits bright light at a particular intensity for a specified period of time, and has been shown to produce an anti-depressant response in various mood disorders (Oren, Wisner, Spinelli et al., 2002; Pail, Huf, Pjrek et al., 2011). TSD involves restricting the amount of sleep an individual receives, normally by preventing sleep for least one night (Schiffer, Rao & Fogel, 2003).

Four studies explored the impact of various chronotherapeutic interventions upon mood symptoms in depressed bipolar individuals (Colombo, Benedetti, Barbini et al., 1999; Benedetti et al., 2007; Wu, Kelsoe, Schachar et al., 2009; Dauphinais, Rosenthal, Terman et al., 2012). Dauphinais et al. (2012) compared the anti-depressant effect of LT to that of negative air ions, and concluded that both treatments were equally effective, with anti-depressant effects lasting up to 8 weeks. Colombo et al. (1999) explored the rate of shifts from depression into mania and hypomania, following three cycles of TSD. The authors observed manic episode shifts in 4.85% of the sample, and shifts into hypomanic episodes in 5.83% of the sample, producing similar effects to those generated by anti-depressant pharmacotherapy (Peet, 1994).

Two studies assessed the efficacy of combined LT and TSD for bipolar depression, reporting significant decreases in symptoms over a matter of days (Benedetti et al., 2007; Wu et al., 2009). Wu et al. (2009) assessed the efficacy of chronotherapy as an adjunct to medication, and found that adjunctive chronotherapy was significantly more effective in reducing symptoms of depression over 7 weeks than medication alone. However, the chronotherapy intervention received by participants included TSD, LT and sleep phase advance treatment. Therefore it is impossible to determine which aspects of this programme were instrumental in producing mood change. The reviewed studies also indicate that chronotherapy is not effective for all depressed bipolar individuals, with numbers of non-responders ranging from 29.6% (n=8/27) to 50% (n=9/18; Benedetti et al., 2007; Wu et al., 2009; Dauphinais et al., 2012).

2.4.6.2 Are social rhythm-stabilising interventions effective in alleviating symptoms of mania and depression in bipolar disorder?

Based on the principles of the social zeitgeber hypothesis, Frank and colleagues (2000) developed a therapeutic approach known as Interpersonal and Social Rhythm Therapy (IPSRT). This approach adopts elements of interpersonal psychotherapy, cognitive behavioural therapy and psychoeducation, with the aim of increasing social rhythm regularity.

Four studies assessed the efficacy of IPSRT for individuals with bipolar disorder (Swartz, Pilkonis, Frank et al., 2005; Swartz, Frank, Frankel et al., 2009; Swartz, Frank & Cheng, 2012; Miklowitz, Otto, Frank et al., 2007). IPSRT demonstrated positive results in reducing symptoms of mania, hypomania and depression (Swartz et al., 2009; 2012). Reported rates of stabilisation were also positive, ranging from 25% (n= 3/12) to 74% (n= 43/58) of the sample (Swartz et al., 2005; 2009; Miklowitz et al., 2007). Of those studied by Swartz et al. (2009), 7 dropped out leaving only 10 participants who had actually received the full 12 week IPSRT intervention. Of these 10 individuals, 3 (i.e. 30%) did not demonstrate a significant treatment

response (i.e. a 50% reduction in depressive symptom scores from baseline). Interestingly, Swartz et al. (2005) found that 75% (n=9/12) of individuals who met diagnostic criteria for both Bipolar I Disorder and Borderline Personality Disorder (BPD), failed to reach stabilisation following IPSRT in comparison to 26% (15/58) of individuals who met criteria for Bipolar I Disorder only.

Shen et al. (2008a) assessed the impact of instructing and encouraging cyclothymic individuals to regulate their daily routines over a period of 4 weeks. Although improvements in mood symptoms and mood variability were observed over time, these changes did not occur as a result of increasing lifestyle regularity. These results imply that the relationship between social rhythm regularity and mood in bipolar populations may not be a direct one, adding support to the social zeitgeber hypothesis and Jones' (2001) account of bipolar disorder.

The reviewed studies also indicate that IPSRT is no more effective than other available forms of treatment for bipolar disorder such as quetiapine, family-focused therapy, or CBT (Miklowitz et al., 2007; Swartz et al., 2012). Similar rates of attrition and treatment satisfaction were also reported when comparing IPSRT with alternative treatment methods.

2.5 Discussion

2.5.1 Summary of the Findings

2.5.1.1 Do non-clinical individuals at high-risk for bipolar disorder exhibit circadian and social rhythm instability?

There is preliminary evidence to suggest that sleep variability rather than sleep quantity or quality, may serve as a useful marker for risk. This idea is supported by qualitative data regarding the importance of regular sleep in euthymic bipolar populations (Murray et al., 2011). In terms of the stability of activity rhythms, both within and across days, the evidence

reviewed suggests that high-risk individuals do not differ significantly from healthy controls. However, preliminary evidence suggests that the amplitude of activity rhythms may serve as a useful marker for risk. Evidence regarding social rhythms indicates a negative relationship between behavioural risk and regularity, which is consistent with the observation of greater variability in the sleep patterns of high-risk individuals.

2.5.1.2 Do euthymic bipolar individuals exhibit circadian and social rhythm instability?

Despite the amount of research concerning sleep during periods of euthymia, the available evidence is very mixed. Euthymic bipolar individuals consistently demonstrated similar SOL, sleep efficiency and WASO in comparison to non-clinical controls when assessed using actigraphy. When viewed independently, these findings suggest that euthymic periods of bipolar disorder are not associated with significant sleep disruption. However, when viewed together with subjective sleep estimates, the evidence indicates that bipolar individuals perceive the quality of their sleep to be much worse. As findings based on actigraphy do not offer insights into sleep architecture, it is possible that sleep quality as defined by the amount of time spent in each sleep stage, rather than defined by actigraphic indices of sleep, is significantly worse in euthymic bipolar populations compared to controls. This is supported by findings of higher REM density in euthymic bipolar individuals. Alternatively, it may be that euthymic bipolar individuals misperceive their sleep, as suggested by Harvey et al. (2005).

Few studies considered activity rhythm instability in euthymic bipolar populations. However, emerging evidence regarding the VI suggests that certain features of activity rhythms may be strongly implicated in bipolar disorder. If replicated, these findings may hold important treatment implications such as the incorporation of actigraphic monitoring within self-management techniques.

The available evidence indicates that euthymic bipolar individuals exhibit lower social rhythm regularity compared to controls, and also tend to experience a higher number of SRD events. This suggests that disruptions in social rhythms are not merely the consequence of severe mood change in bipolar disorder, but are present throughout. When viewed together with evidence of social rhythm regularity in high-risk populations, the research suggests that low social rhythm regularity may serve as a trait marker for bipolar illness.

2.5.1.3 How does circadian and social rhythm instability interact with mood in bipolar disorder?

The available evidence suggests that the relationship between rhythmic disturbances and mood in bipolar disorder may be bi-directional. Evidence of significant associations between sleep duration and mood symptoms during euthymia, adds further support to models which emphasize the role of circadian rhythm disruption in bipolar mood change (Goodwin & Jamison, 1990; Jones, 2001). These findings also hold important treatment implications, suggesting that the objective self-monitoring of sleep duration may be useful in identifying prodromal signs of an oncoming mood episode.

Emerging evidence regarding the VI suggests that activity rhythms differ significantly across mood episodes. Such evidence suggests that the relationship between activity rhythms and clinical states may be much more complex than once thought, with differences between clinical groups only becoming visible when we consider complex equations such as the VI, rather than focusing on average levels of activity.

Studies concerning the relationship between social rhythms and mood in bipolar disorder, are severely lacking. Based on the available evidence, SRD events appear to be more strongly related to periods of mania and depression than periods of hypomania or cyclothymia, reflecting differences in the severity of these episodes (American Psychiatric Association, 2000).

2.5.1.4 Are interventions which target circadian and social rhythms effective for individuals with bipolar disorder?

Chronotherapeutic interventions demonstrated significant, short-term, anti-depressant treatment effects. Similarly, IPSRT was shown to produce positive, albeit modest, treatment effects during acute bipolar mood states. Studies which have compared IPSRT with other psychotherapeutic treatments, in addition to medication, suggest that these treatments are equally effective in terms of reducing symptom severity and promoting recovery in bipolar disorder. However, there is also evidence to suggest that comorbidities in bipolar disorder may have a detrimental impact on treatment response.

2.5.2 Implications for Future Research and Practice

Available evidence regarding relationships between circadian and social rhythms and risk for bipolar disorder, is severely lacking. Since the review of Grandin et al. (2006), which emphasized the need for further research into social rhythm regularity in high-risk individuals, there have been only two such investigations. It is crucial that future research efforts are directed towards the assessment of circadian and social rhythm instability in populations considered at risk, to validate preliminary evidence of increased sleep pattern variability, lower social rhythm regularity, and reduced activity rhythm amplitudes in high-risk populations. Exploration of circadian and social rhythm abnormalities in familial high-risk populations also demands further attention, particularly in light of theories which emphasize the role of genes in circadian functioning (McClung, 2007; 2011; Murray & Harvey, 2010). Identification of vulnerability markers for bipolar disorder will improve our understanding of the development of the disorder, whilst also informing screening protocols and preventative interventions.

Conflicting evidence regarding objective versus subjective sleep estimates, highlights the need to re-evaluate definitions of sleep quality in bipolar disorder. Further research is also

required to investigate claims that euthymic bipolar individuals may misperceive their sleep, as this will have important implications for cognitive interventions. Mixed evidence concerning circadian disturbances in bipolar populations, may partly relate to inconsistencies in how certain methodologies are applied. The methodological characteristics of actigraphy studies for example, vary widely from the type of actiwatch used to the scoring algorithm employed. There is evidence to suggest that these subtle differences may influence the sensitivity and specificity of various sleep parameters including sleep duration and SOL (Boudebesse, Leboyer, Begley et al., 2013), indicating that some designs will be better suited than others in answering particular questions. This demonstrates the importance of future investigations to provide detail and clarity in the methodology used so that accurate comparisons may be drawn between studies.

Although available evidence points to a significant relationship between sleep duration and symptoms of mania and depression in bipolar disorder, our understanding of the processes which underlie this relationship remains limited. Previous studies have highlighted a number of factors which may influence the relationship between circadian disturbance and mood, from dopaminergic pathways to appraisal style (Murray & Harvey, 2010; Jones, 2001). Future investigations should seek to examine potential interactions between these variables to improve our understanding of this relationship. Central to this issue is the need for more sophisticated designs which include populations who exhibit similar abnormalities in circadian and social rhythms to bipolar populations, and yet do not experience the same degree of mood disturbance. This will allow for the examination of underlying factors which may interact with rhythmic disturbances to produce mood change in bipolar disorder.

Evidence regarding relationships between social rhythm regularity and mood indicate that interventions aimed at stabilising social rhythms, such as IPSRT, may be more effective in preventing relapse for individuals with Bipolar I than Bipolar II disorder. It is therefore important that future investigations explore circadian and social rhythm instability across different bipolar subtypes.

In terms of activity rhythm abnormalities, emerging evidence concerning the VI suggests that the relationship between physical activity and bipolar disorder is highly significant. It is hoped that research teams will continue to explore the role of the VI in bipolar disorder and similar conditions, particularly with regard to mood change.

None of the studies identified in the present review explored chronotherapeutic approaches for mania. This is an area that demands further exploration, particularly given preliminary evidence of a negative relationship between sleep duration and (hypo)mania (Liebenluft et al., 1996). Further research into possible treatment mechanisms underlying chronotherapeutic treatments has been previously advocated by Murray and Harvey (2010). However, we were only able to identify one such study which had been published after 2010. The available evidence indicates that chronotherapeutic interventions can be very effective, and are also viewed favourably by service users. However, this evidence is limited in that it does not address the long-term effects of chronotherapy, nor offer any indication as to the mechanisms underlying these anti-depressant effects.

Evidence concerning the efficacy of interventions which target circadian and social rhythm processes, is limited in terms of sample size and follow-up period. Without further replication of these findings on a larger scale, it is unclear how effective such interventions are in the long-term. This information will be essential in assessing the cost-effectiveness of alternative treatment options for individuals with bipolar disorder, and is particularly important given the current economic climate and proposed cuts to NHS services (Roberts, Marshall & Charlesworth, 2012).

2.5.3 Limitations of the Present Review

In drawing attention to the methodological drawbacks of the studies reviewed, it is also important to acknowledge the limitations of the review itself. Only studies available in English were included, which may have caused a bias towards identification of studies

conducted by research teams in the USA. Dissertation abstracts were also excluded, which may have resulted in unpublished, significant findings being overlooked.

Due to the focus on circadian rhythm instability within adult populations, it is possible that relevant studies involving familial high-risk populations, such as children of bipolar parents, were overlooked. However, due to the developmental changes in sleep-wake patterns that take place during childhood through to adolescence (see Harvey, Mullin & Hinshaw, 2006 for a review), it was felt that restricting the age of the samples studied to 18 and above would enable a more accurate comparison between other high-risk studies involving adults. This is particularly relevant given evidence that the “adult” sleep cycle only becomes established during adolescence (Carskadon & Dement, 2005).

Whilst we have attempted to synthesize findings of different studies in order to provide a comprehensive review of the evidence, advances in actigraphy technology over the past decade may invalidate direct comparisons between similar studies due to differences in how the data is processed within different devices (Welk, McClain & Ainsworth, 2012). Therefore discrepancies in the findings of old and new actigraphy studies should be viewed with this in mind.

2.5.4 Conclusion

The present review examined the relationship between circadian and social rhythm instability, and mood in bipolar disorder. Preliminary evidence of circadian and social rhythm abnormalities in populations at behavioural high-risk for bipolar disorder, was identified. Inconsistencies regarding reports of sleep quality and social rhythm regularity in bipolar disorder, highlight a number of methodological issues that require attention in future investigations. The state of the evidence concerning abnormalities in activity rhythms in bipolar disorder is also unclear, mainly due to a lack of research in this area. However, recent evidence of a ‘vulnerability index’ in bipolar disorder has opened up a new and exciting area

of investigation that will hopefully serve to clarify the nature of activity rhythms in bipolar disorder. Although there is evidence that interventions which target rhythmic disturbance produce positive outcomes for individuals with bipolar disorder, the underlying mechanisms involved, in addition to the long-term efficacy of these interventions, is under-researched. We therefore urge research teams to concentrate their efforts on improving current understanding of these issues.

2.6 References

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Cognitive Styles Throughout the Course of Bipolar Disorder

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3.1 Abstract

Bipolar disorder is characterised by extreme shifts in mood which can have a deleterious impact upon one's quality of life and ability to function. Interest in the role of cognition in bipolar disorder has increased over recent years, stimulating the development of multilevel cognitive models of bipolar disorder which emphasize the importance of multiple and interacting cognitive processes. To assess the validity of these models, the present review examined available evidence concerning the role of cognitive styles in both non-clinical high-risk populations, and clinical bipolar populations. Integration of the findings suggests that individuals at familial high-risk for bipolar disorder do not exhibit maladaptive cognitive styles. Conversely, behavioural risk for bipolar disorder was positively related to dysfunctional attitudes and a tendency to form multiple, internal appraisals of experiences. The evidence reviewed also indicates an important role for negative cognitive styles in bipolar disorder. Cognitive interventions, which target maladaptive attitudes, were associated with short-term, positive treatment effects. However it is uncertain how strongly these effects correspond to changes in cognitive style. Implications of the findings are discussed with reference to areas requiring further research.

3.2 Introduction

Fluctuations in mood are a part of everyday life, from feeling frustrated when things do not turn out as planned, to feeling positive when things go well. However, in bipolar disorder these shifts in mood can be extreme and severely debilitating. For some individuals, positive moods may develop into full manic episodes, characterised by elation, racing thoughts, increased energy and an abundance of new ideas (American Psychiatric Association, 2000). Other individuals may experience less extreme elevations in mood, often referred to as hypomania, which do not impact so significantly upon an individual's ability to function normally.

There are a number of models which attempt to explain the processes underlying mood change in bipolar disorder. It is now widely accepted that the development of the disorder involves a combination of biological, environmental and psychological factors (Brietzke, Mansur, Soczynska et al., 2012), though different models vary greatly in the emphasis placed upon these separate components. For example, genetic models of bipolar disorder suggest that bipolar mood change is primarily triggered by the interaction of certain genes which activate or deactivate the transmission of neurotransmitters, such as dopamine and glutamate (Berk, Dodd, Kauer-Sant'Anna et al., 2007; Cherlyn, Woon, Liu et al., 2010). Whilst biological models of bipolar disorder are useful in understanding the role of familial risk factors and disruptions in circadian rhythms, such models are often unable to account for the varied presentation of bipolar disorder (Jones, Hayward & Lam, 2002). Furthermore, current evidence regarding the role of candidate genes in bipolar disorder suggests that such factors only contribute a small amount to the susceptibility and recurrence of bipolar mood episodes (Greenwood, Badner, Byerley et al., 2013).

Research into psychosocial factors associated with bipolar disorder, such as life events and cognitive style, indicates that non-biological factors play an important role in the aetiology of the disorder (Jones, Lobban & Cooke, 2010). One of the first cognitive models of

mood was proposed by Beck (1967) as an explanation for depression. According to this model, experiences in early life shape an individual's view of themselves, their future and the environment in which they live. Traumatic life experiences are said to cause negative thinking styles which become activated in response to similar, subsequent life events (Beck, 1967). Over time these thinking styles become reinforced by further events representing trait-like cognitive styles which lead to the tendency to misinterpret events and experiences. For example, an individual may develop a cognitive style in which he or she views themselves as inadequate and undesirable, perceives the world as threatening, and views the future as hopeless. Negative life events will then be processed within these maladaptive cognitions leading to increases in low mood (Beck, 1967). Teasdale (1983, 1988) later built upon this model by adding that low moods may also activate negative cognitions, creating a vicious cycle of worsening mood. This 'differential activation hypothesis' (DAH; Teasdale, 1983, 1988), asserts that cognitive styles are established during early episodes of depression, thus creating an association between feeling low and thinking negatively.

The importance of cognitive styles has since been applied to the development of mood episodes in bipolar disorder (Newman, Leahy, Beck et al., 2002). It is suggested that events, such as circadian rhythm disruption, activate maladaptive schemas which have developed over time as a result of early life experiences. Once activated, these schemas cause biases in information processing by highlighting information which is consistent with the schema. For example, during a manic episode the schema "I am talented" may direct attention towards the achievement of goals. Conversely during a depressed episode, the schema "I am a failure" may direct memory retrieval towards previous experiences of failure. It is suggested that biases in information processing exacerbate the impact of maladaptive cognitions, leading to the onset of extreme mood states. Newman et al. (2002) propose that irritability, often observed during mixed episodes in bipolar disorder, reflects the presence of these conflicting cognitions.

It is also suggested that the activation of maladaptive schemas leads to maladaptive coping strategies which create self-sustaining mood states. For example, during a depressive episode the schema “I am unlovable” may be activated as a result of a relationship breakdown. This schema may then trigger faulty information processing and lead to a coping strategy which involves becoming socially withdrawn so as to prevent further experiences of rejection. Such behaviour may promote a lonely, isolating environment, thus reinforcing the schema “I am unlovable” and triggering further negative emotion.

Newman et al. (2002) also suggest that the relationship between cognition and mood in bipolar disorder is bi-directional, such that the polarity of an underlying schema is determined by an individual’s mood state. For example, the schema “I am a failure” may be exaggerated to “I only make things worse and the world is better off without me” during a depressed state. Yet during a manic state, this schema may be shifted towards the opposite end of the spectrum e.g. “I can succeed at anything I want”.

Whilst early cognitive models are able to account for the presence of complex presentations in bipolar disorder, such as mixed states, the nature of the underlying subsystems involved is somewhat vague. More recent multilevel cognitive models offer greater detail into these processes, and therefore present new avenues for research into therapeutic mechanisms which will inform and improve psychological treatment approaches. Therefore the focus of the present review will be to evaluate existing literature concerning cognitive styles in bipolar disorder, in relation to more comprehensive multilevel approaches.

In 1997, Power and Dagleish presented the Schematic, Propositional, Analogical and Associative Representation Systems (SPAARS) model which illustrated how emotions may be generated via direct, associative routes in addition to the schematic routes described by Beck (1967) and Teasdale (1983, 1988). According to this model, an event is initially processed by the analogical system which is concerned with sensory information, i.e. visual, auditory, tactile, gustatory, olfactory and proprioceptive. This information is then processed at

three different levels; propositional, associative, and schematic, which feed into one another and may generate conflicting emotions (see Appendix 2). At the propositional level, information is processed within the context of true or false statements such as “It is raining outside”. Although these propositional appraisals cannot directly influence emotional states, they feed into, and are influenced by, associative and schematic processes. Schematic appraisals reflect the influence of personally-relevant schema relating to the self, the world and others, such as “I am inadequate”, which then triggers an emotional reaction. At the associative level, information is processed in relation to learned associations from previous similar experiences, such as associating a particular piece of music with feeling relaxed. At the associative level, information does not require schematic interpretation to trigger mood change.

In 2001, Jones applied the SPAARS model to explain the development of extreme mood states in bipolar disorder (see Appendix 1). Incorporating evidence of circadian rhythm instability in bipolar disorder, Jones (2001) argues that bipolar mood change is initially triggered by circadian rhythm-disrupting events, causing a change in internal state at the analogical level (i.e. an increase or decrease in energy/mental activity). For example, a knee injury may disrupt sleeping patterns causing fatigue. It is proposed that this feeling of physical fatigue is then processed within the three systems of representation outlined above. However, for individuals vulnerable to bipolar disorder, it is claimed that an internal cognitive bias pervades these levels of processing, such that both positive and negative changes in internal state are attributed to the individual themselves, resulting in extreme mood states (Jones, 2001). This may then lead to “ascent” or “descent” behaviours (i.e. behaviours which aim to increase or decrease levels of activation; Mansell, Morrison, Reid et al., 2007), which further exacerbate circadian rhythm disruption, creating a vicious cycle of mood escalation.

In the present review, we will consider the extent to which certain cognitive styles are unique to bipolar disorder, and also explore the extent to which multilevel cognitive models of mood may be applied to non-clinical high-risk populations. Evidence regarding the

relationship between cognitive styles and clinical states and symptoms in bipolar disorder will be assessed, in addition to evidence pertaining to state and trait-like cognitive processes. Finally, we will assess the efficacy of cognitive interventions for bipolar disorder and make suggestions for future research.

3.2.1 Description of Cognitive Style Measures

3.2.1.1 Attribution

Cognitive styles are often measured in terms of attributions, or causal explanations for events. The Attributional Style Questionnaire (ASQ; Peterson, Semmel, von Baeyer et al., 1982) was initially developed with reference to the learned helplessness model of depression which describes depression as a response to uncontrollable, negative life events (Abramson, Seligman & Teasdale, 1978). According to this approach, the severity of depressed mood triggered by such events is dictated by attributional style. Attributional style is described within three key concepts; internality, stability and specificity (Abramson et al., 1978). Internality refers to the extent to which an event is perceived as being caused by the individual (i.e. internal attribution) or as a result of external factors (i.e. external attribution). Specificity refers to the extent to which an event is perceived as resulting from the specific conditions of a given situation (i.e. specific attribution) , as opposed to relating to any given situation (i.e. global attribution). Finally, stability refers to the extent to which an event is believed to be caused by stable, fixed factors (i.e. stable attribution) rather than temporary factors (i.e. unstable attribution). According to the learned helplessness model, individuals who form internal, stable and global attributions for uncontrollable negative events, will be at an increased risk of depression (Abramson et al., 1978). The ASQ is therefore intended to assess attributional styles for hypothetical positive and negative events with respect to these three indices, such that respondents indicate the extent to which they would perceive each event as due to stable, specific and internal causes. Similar measures of trait-like attributional style

include the Internal, Personal, and Situational Attributions Questionnaire (IPSAQ; Kinderman & Bentall; 1996) and the Cognitive Style Questionnaire (CSQ; Alloy, Abramson, Hogan et al., 2000).

3.2.1.2 Attitudes

The Dysfunctional Attitudes Scale (DAS; Weissman & Beck, 1978) is one of the most widely used measures of negative cognitive style in psychological research (Dozois, Covin & Brinker, 2003). It was developed with reference to Beck's (1967) cognitive theory of depression, and is therefore intended to assess negative attitudes towards the self, world and future (Weissman & Beck, 1978). The DAS requires respondents to indicate the extent to which they agree with statements representing such negative attitudes (e.g. "I should be able to please everybody"), with higher scores indicating stronger dysfunctional attitudes.

The DAS can be separated into various subscales including Goal-Attainment, Dependency/Approval, Anti-Dependency, Achievement, Performance, and Self-Control. Dependency/Approval attitudes refer to the need to receive validation from others (e.g. "If others dislike you, you cannot be happy"), with Anti-Dependency representing the opposite (e.g. "I don't need approval from others to be happy"). Self-Control attitudes reflect risk-averse beliefs concerning the importance of controlling one's emotions (e.g. "I should always have complete control over my feelings"). Goal-Attainment attitudes reflect unrealistic goal-striving and drive (e.g. "I ought to be able to solve all my problems quickly"), with Achievement attitudes reflecting the importance of success in relation to self-worth (e.g. "If I fail partly, it is as bad as being a complete failure"). Similarly, Performance Evaluation attitudes reflect perfectionistic beliefs and concerns regarding disapproval from others (e.g. "If I do not do well all the time, people will not respect me").

3.2.1.3 Appraisal

Only in recent years have researchers turned their attentions towards developing scales specifically designed to measure bipolar-specific cognitions (Mansell, 2006). In accordance with Jones' (2001) model of bipolar disorder, Jones and colleagues developed the Hypomanic Interpretations Questionnaire (HIQ; Jones, Mansell & Waller, 2006b) as a measure of internal, self-dispositional appraisals for experiences related to hypomania. The Interpretations of Depression Questionnaire (IDQ; Jones & Day, 2008) was later developed to assess negative self-appraisals of experiences related to depression. In both cases, respondents are asked to rate the extent to which they agree with an internal appraisal, and an external-normalising appraisal, of an experience. Thus each measure is composed of two subscales; an internal appraisal subscale (i.e. the HIQ-H and the IDQ-D) and a normalising appraisal subscale (i.e. the HIQ-N and the IDQ-N). Scores on the HIQ-H have been found to relate positively to hypomanic personality traits (Jones et al., 2006b), whilst scores on the IDQ-D have been found to positively correlate with symptoms of depression (Jones & Day, 2008).

The Hypomanic Attitudes and Positive Predictions Inventory (HAPPI; Mansell & Jones, 2006) is based upon the ideas proposed in the Integrative Cognitive Model (Mansell et al., 2007), and is designed to assess conflicting, trait-like beliefs about internal states. Respondents are presented with a set of statements reflecting extreme appraisals of internal states (e.g. "Unless I am active all the time, I will end up a failure") and are instructed to indicate the extent to which they believe each statement. Factor analyses of the HAPPI indicate the presence of 5 to 6 separate factors (Mansell, Rigby, Tai & Lowe, 2008; Dodd, Mansell, Morrison & Tai, 2011a). Commonly reported factors include Success-Activation, Activating Response Style, and Loss of Control. Scores on the Success-Activation subscale indicate excessively positive beliefs about feeling high, whereas scores on the Loss of Control subscale represent beliefs that one's mood and behaviour is unmanageable when feeling high (Dodd et al., 2011a). Finally, Activating Response Style subscale scores are reflective of beliefs around the need to respond to activation with increased activity to avoid failure.

3.3 Method

3.3.1 Search Strategy

A literature search was performed within four online databases; PsycINFO, MEDLINE, AMED and CINAHL. To improve the relevance of the results, the search was conducted within abstracts only, using the following search terms; “bipolar*” OR “cyclothymia” OR “mania” OR “hypomania” OR “manic depression” AND “appraisal” OR “attribution” OR “cognitive style” OR “schema” OR “attitude” OR “belief”. These terms were identified based upon their relevance to the research question, in addition to discussion with experts in the field of cognitive styles in bipolar disorder.

3.3.2 Inclusion and Exclusion Criteria

A paper was eligible if: a) the study included participants who met criteria for a diagnosis of bipolar disorder, and/or were classified as being at-risk for developing bipolar disorder; and b) study participants were aged 13 and over. This latter criterion is based on the observation that cognitive styles stabilise around the age of 12 (Gibb, Alloy, Walshaw et al., 2006).

A paper was excluded if: a) the paper was not available in English; b) the paper was a literature review, meta-analysis, case study, dissertation abstract or letter; and c) the study was irrelevant to the research question (i.e. did not involve assessment of appraisals relating to the self, such as studies assessing beliefs around treatment or smoking cessation).

Where possible, the above criteria were applied to the initial search in each database via search limiters (see Figure 1). The title and abstract of the resulting papers were then screened (i.e. read by the first author) to ensure that all inclusion criteria had been met. Duplicate results from different databases were removed, as were studies reporting the same findings from a single data set.

3.3.3 Assessment of Quality

After papers had been screened to ensure their eligibility, the methodological quality of each paper was assessed in accordance with the online CASP resources (Critical Appraisal Skills Programme, 2010). The CASP tools encourage researchers to evaluate evidence based upon a series of key criteria including how participants were identified, how the data were analysed, and the reporting of the results. The CASP tools have been used to review evidence across a range of disciplines, including psychology (Kaltenthaler, Parry, Beverley & Ferriter, 2008).

Throughout the quality assessment it was important to assess the degree to which reported findings could be applied to the wider bipolar population. Therefore any studies which were deemed to have used unrepresentative samples (e.g. all male sample, sample size less than 10) were excluded at this stage. Studies which identified participants based on unvalidated diagnostic methods (e.g. a self-reported diagnosis of bipolar disorder with no formal assessment) were also excluded due to concerns regarding the validity of the results.

3.3.4 Grouping of Studies

The combined search from all four databases generated 835 hits. Search limiters were then applied where possible, in line with the inclusion/exclusion criteria outlined above (see Figure 1). This left 398 papers which were reviewed by the first author to check for suitability against inclusion/exclusion criteria which had not been addressed by the search limiters (e.g. relevance to the research question). A total of 47 papers were then assessed using the CASP tools, of which 5 papers were excluded. One paper was excluded due to the absence of a formal diagnostic instrument. A further four were excluded due to concerns regarding the generalizability of the samples studied (i.e. 100% female samples, samples sizes ranging from 2 to 10). This left 42 which were deemed to be of suitable quality and relevance to the research question.

Although widely used, it is not always appropriate to perform a meta-analysis to aggregate information from studies which differ greatly in design and quality (Ahlbom, 1993). Due to differences in the demographic characteristics of the samples studied (e.g. adolescents versus adults), in addition to variation in study design, a meta-analysis was not performed upon the studies identified in the present review.

Studies were grouped primarily according to the type of cognition assessed (i.e. appraisal, attribution, attitude) and were then grouped according to the population under investigation (i.e. non-clinical high-risk populations, euthymic bipolar populations, and episodic bipolar populations).

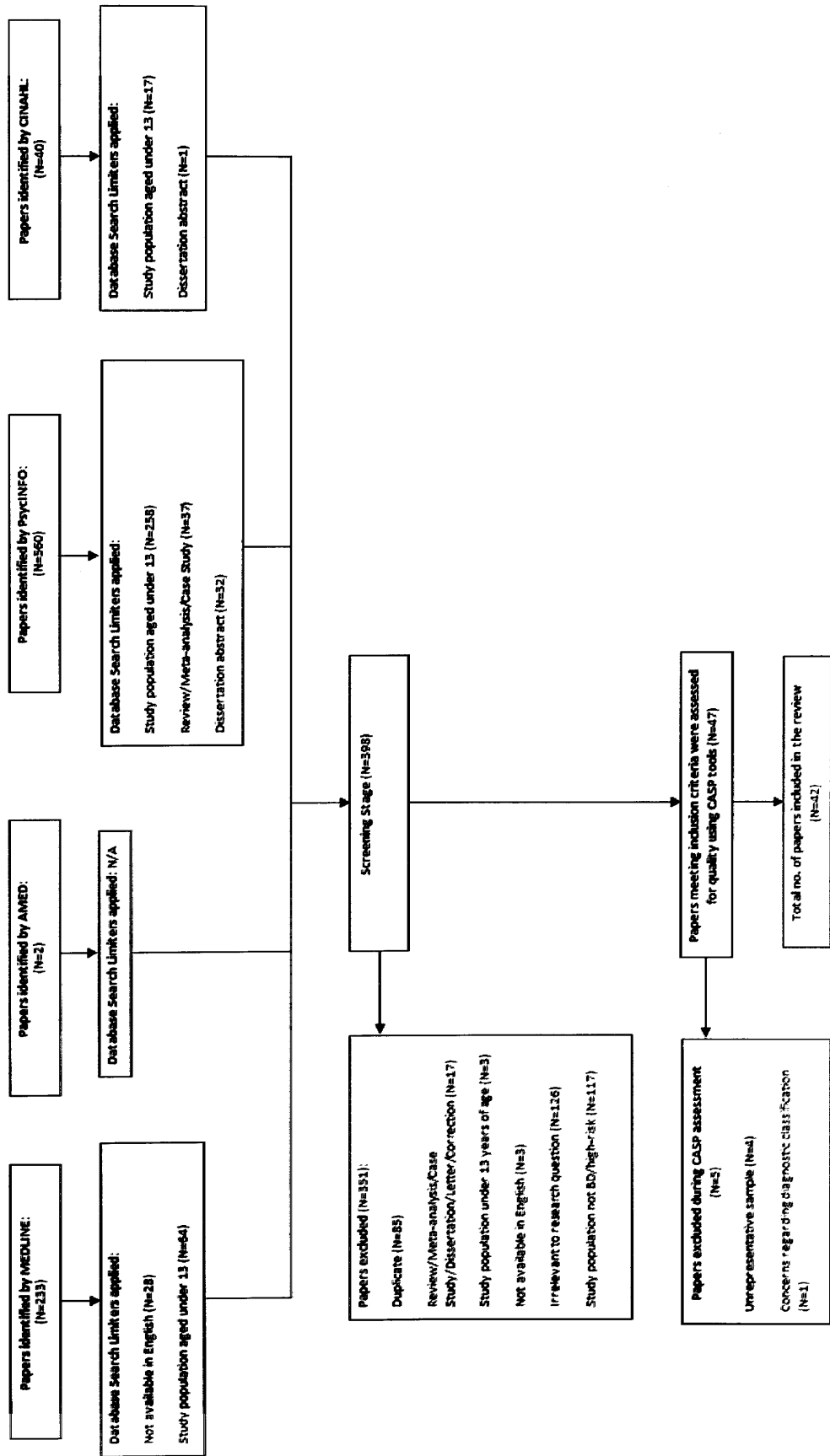


Figure 1. Procedure for study selection

3.4 Results

3.4.1 Overview of Studies

All studies were published between 1999 and 2013 (see Table 1). The studies took place across 7 countries, the majority conducted within the UK (n=25). Many studies adopted cross-sectional designs (n=35), and total sample size ranged from 38 (Lex, Meyer, Marquart & Thau, 2008) to 651 (Jones, Scott, Haque et al., 2005).

The selected studies concerned clinical bipolar populations (n=26), populations at behavioural high-risk for bipolar disorder (n=15), and/or individuals at familial high-risk (n=3). Of the three familial high-risk studies, two assessed samples of children whose parents had a diagnosis of bipolar disorder (Espie, Jones, Vance & Tai, 2012; Jones et al., 2006a) whilst the other study assessed first degree relatives of individuals with a diagnosis (Jabben, Arts, Jongen et al., 2012). Most behavioural risk studies defined participants based upon scores on the Hypomanic Personality Scale (HPS; Eckblad & Chapman, 1986; n=11), with other studies defining behavioural risk using the Behavioural Inhibition and Behavioural Activation Scales (BIS/BAS Scales; Carver & White, 1994; n=2) and the General Behaviour Inventory (GBI; Depue, Krauss, Spoont & Arbisi, 1989; n=1). One study examined cognitive styles in both HPS- and BIS/BAS-defined behavioural high-risk individuals (Meyer, Barton, Baur & Jordan, 2010).

Studies concerning clinical bipolar populations mainly assessed pure Bipolar I samples (n=12), with only 7 including individuals who met criteria for Bipolar II Disorder. Seven studies did not specify the diagnostic characteristics of the bipolar sample studied. Five studies compared cognitive styles in bipolar and unipolar populations. Only one study assessed cognitive styles in individuals with a diagnosis of schizophrenia (Donohoe, Duignan, Hargreaves et al., 2012). A diagnosis of bipolar disorder was largely determined using the Structured Clinical Interview for DSM-IV Disorders (SCID; First, Spitzer, Gibbon et al., 1997; n=22), with other measures including the Schedule for Affective Disorders and Schizophrenia-Lifetime Version (SADS-L; Endicott & Spitzer, 1978; n=4), the Mini-International Neuropsychiatric Interview (MINI; Sheehan, Lecrubier,

Sheehan et al., 1998; n=3), the International Classification of Diseases (ICD-10; World Health Organization, 1993; n=3), the Composite International Diagnostic Inventory (CIDI; Robins, Wing, Wittchen et al., 1988, n=1) and Research Diagnostic Criteria (RDC; Spitzer, Endicott & Robins, 1978; n=1). A minority of studies did not report using a specific diagnostic instrument, but stated that participants were diagnostically classified according to criteria listed in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV criteria; American Psychiatric Association, 2000; n=2).

The majority of studies focused on dysfunctional attitudes (n=30), with fifteen studies examining appraisals, and nine studies assessing attributional style. Dysfunctional attitudes were mainly assessed directly using the DAS (n=29), with only one study assessing implicit dysfunctional attitudes (Thomas, Bentall, Knowles & Tai, 2009). Seven studies investigated appraisal styles for hypomanic experiences using the HIQ. Appraisals of depressive experiences were assessed using the IDQ by only two studies. Six studies assessed extreme, multiple, conflicting appraisal styles using the HAPPI. Trait-like attributional styles tended to be measured using the ASQ (n=4), with other measures including the IPSAQ (n=1) and the CSQ (n=1). One study employed the Pragmatic Inference Task (PIT; Winters & Neale, 1985) to implicitly assess attributions for positive and negative events. Only two studies assessed concurrent attributional styles (Bentall, Myin-Germeys, Smith et al., 2011; Meyer et al., 2010). Bentall et al. (2011) included attribution questions within a daily questionnaire. Participants were asked to report the most negative and most positive event that had happened to them that day, and to then rate how much they believed each event was caused by their own actions or the actions of others/circumstance. Meyer and colleagues (2010) adapted the CSQ so that the questions referred to attributions for success on a task, thus creating the Current Attribution Questionnaire (CAQ).

Table 1. Summary of studies identified by review

Author (Date)	Design	Participants (N)	Adequate Power at 80%	Diagnostic Classification	Measure of Cognition	Location	Key Findings
Alatiq et al. (2010)	C	BP (40) UP (20) CO (20)	Yes	MINI	HAPPI, DAS	UK	No group differences in total DAS or DAS subscale scores. BP scored higher on total HAPPI, and the 'Other Negative Beliefs' and 'Response Styles' subscales of the HAPPI compared to UP & CO.
Ankers & Jones (2009)	C	HR (31) CO (24)	-	SCID, HPS	HIQ	UK	HR scored higher on ISS-A, ISS-PC, HIQ-H & HIQ-E compared to CO. There were no group differences on the HIQ-N, HIQ-H scores significantly contributed to the classification of HR vs CO.
Babakhani & Startup (2012)	C	BP (49) CO (37)	-	SCID, GBI	DAS	Australia	In both BP & CO, total DAS was higher after the NMI than after the PMI. BP DAS subscale scores after the PMI, were similar to the CO scores after the NMI. BP exhibited higher DAS-A scores than CO, across both MI conditions.
Ball et al. (2006)	I	BP (52)	No	SCID	DAS	Australia	Those who received CT demonstrated a greater reduction in depressive symptom scores compared to those who received TAU. No group differences in DAS scores, or relapse rates at 12 month FU, were observed.
Bentall et al. (2011)	C	CO (55) MR (31) HR (54)	-	SCID, HPS	DAS, Attribution Items	UK	HPS & DAS scores predicted broad BSD, however only HPS scores predicted

Table 1. (continued)

Author (Date)	Design	Participants (N)	Adequate Power at 80%	Diagnostic Classification	Measure of Cognition	Location	Key Findings
Chen & Johnson (2012)	C	GP (228)	-	HPS	DAS	USA	narrowly-defined, lifetime BSD. HPS scores positively correlated with DAS-GA & DAS-A attitudes.
Dempsev et al. (2011)	C	GP (353)	-	HPS	HIQ, IDQ	UK	HPS scores positively correlated with the HIQ-H & IDQ-D, but not the normalising subscales. Depressive symptom scores positively correlated with IDQ-D & HIQ-N subscales. HIQ-H scores contributed to variance in HPS scores. IDQ-D scores contributed to variance in depressive symptom scores.
Dodd et al. (2011a)	L	BP (50)	-	SCID	HIQ, HAPPI	UK	At 4 week FU only baseline HAPPI scores predicted ISS-A & ISS-PC. Loss of Control, Success Activation & Triumph Over Fear predicted ISS-D, and Increasing Activation to Avoid Failure predicted ISS-A.
Dodd et al. (2011b)	C	HR (18) UR (20) CO (30)	-	GBI	HAPPI	UK	HAPPI scores did not differ significantly between HR & UR, however both HR & UR scored higher on the HAPPI than CO. GBI Hypomania was negatively associated with Other Negative, Catastrophic, & Loss of Control appraisals. GBI Hypomania was

Table 1. (continued)

Author (Date)	Design	Participants (N)	Adequate Power at 80%	Diagnostic Classification	Measure of Cognition	Location	Key Findings
Donohoe et al. (2012)	C	BP (102) SZ (208) CO (132)	-	SCID	IPSAQ	UK	positively associated with Self-Positive and Optimistic appraisals. GBI Depression was positively associated with Catastrophic, Other Negative, Loss of Control, and Situational appraisals. GBI Depression was negatively associated with Self-Positive and Optimistic appraisals.
Espie et al. (2012)	C	FR (23) CO (24)	-	SCID, SADS-L	ASQ, HIQ	UK	BP did not differ from the other groups on the personalizing or externalizing bias subscales of the IPSAQ. Scores on the personalizing subscale correlated positively with negative symptoms.
Goldberg et al. (2008)	C	BP (34) UP (35) CO (29)	-	SCID	DAS	USA	No significant group differences were observed in HPS, HIQ-H, ASQ-N, or ASQ-P. HIQ-H scores significantly predicted scores on the HPS.
Jabben et al. (2012)	C	BP (77) FR (39) CO (61)	-	RDC, OCCPI	DAS	Netherlands	DAS scores were highest in UP, followed by BP and CO. Mania symptom scores positively correlated with DAS scores in the BP group only.
							Depressed BP scored highest on DAS-GA & DAS-A, followed by euthymic BP, FR & CO. No significant differences

Table 1. (continued)

Author (Date)	Design	Participants (N)	Adequate Power at 80%	Diagnostic Classification	Measure of Cognition	Location	Key Findings
Johnson & Jones (2009)	C	GP (638)	-	HPS	HIQ	USA/UK	between FR and CO were observed. HPS scores positively correlated with the overly-positive interpretations of hypomanic symptoms factor. HIQ-N attributes were not significantly related to HPS scores.
Johnson & Fingerhut (2004)	L	BP (60)	-	SCID	DAS	USA	DAS scores positively correlated with depressive, but not manic, symptom scores at baseline and FU. Number of previous mood episodes were not significantly related to DAS scores.
Jones et al. (2005)	C	BP (118) UP (265) CO (268)	Yes	ICD-10, RDC, DSM-IV Criteria, SCAN	DAS	UK	DAS scores were highest in UP, followed by BP and CO.
Jones et al. (2006a)	C	BP (20) CO (19) CCO (22) FR (25)	-	SCID	DAS	UK	No significant group differences in DAS scores were observed. Trend for higher DAS scores in BP compared to CO.
Jones et al. (2006b)	C	GP (203)	-	HPS	HIQ, DAS	UK	HIQ-H & DAS scores significantly contributed to variance in HPS scores.
Jones et al. (2007)	C	GP (173)	-	HPS	DAS	UK	No significant correlation between DAS and HPS scores.

Table 1. (continued)

Author (Date)	Design	Participants (N)	Adequate Power at 80%	Diagnostic Classification	Measure of Cognition	Location	Key Findings
Jones & Day (2008)	C	GP (231)	-	HPS	IDQ, HIQ, DAS	UK	IDQ-D scores positively correlated with HPS scores, and contributed to variance in CES-D scores. HIQ-H scores positively correlated with ISS-A & ISS-WB, and contributed to variance in HPS scores. DAS scores positively correlated with ISS-PC, ISS-D & CES-D, and negatively correlated with ISS-WB. HIQ-N scores positively correlated with ISS-A scores.
Kelly et al. (2011)	C	BP (171) UP (42) CO (64)	-	SCID, MINI	HAPPI	UK	High scores on both the positive and negative appraisal items of the HAPPI differentiated BP from CO, and BP from UP.
Knowles et al. (2005)	C	GP (528)	-	HPS	DAS	UK	DAS scores positively correlated with HPS scores.
Knowles et al. (2007)	C	BP (18) UP (16) CO (19)	-	SCID	PTT	UK	BP & UP made more internal attributions for negative events than positive events, whereas CO showed reverse pattern.
Lam et al. (2004)	C	BP (143) UP (109)	-	SCID	DAS	UK	DAS-GA scores positively correlated with BDI scores in UP but not BP. After controlling for ISS-A & BDI, BP had higher DAS-C & DAS-GA scores than UP.

Table 1. (continued)

Author (Date)	Design	Participants (N)	Adequate Power at 80%	Diagnostic Classification	Measure of Cognition	Location	Key Findings
Lam et al. (2005)	I	BP (103)	-	SCID	DAS	UK	48% of participants receiving MPC experienced at least 1 ME compared to 30% of those who received CT. Those who received CT also experienced fewer days in hospital. After controlling for BDI & MRS, DAS-GA significantly contributed to total SHPSS scores.
Lee et al. (2010)	C	BP (54)	-	SCID	DAS	UK	Total DAS scores positively correlated with scores on the BDI & SHPSS-Ideal. DAS-GA also positively correlated with SHPSS-Ideal scores.
Lex et al. (2008)	C	BP (19) CO (19)	-	SCID	DAS	Austria	No significant group differences in DAS scores, were observed. Trend for higher DAS scores in BP compared to CO.
Lex et al. (2011)	C	BPH (15) BPR (26) CO (21)	-	ICD-10	DAS, ASQ	Austria	BPH scored higher on DAS than CO. BPR did not differ significantly from either group. No significant group differences in attributions for negative events were observed. BPH displayed a more optimistic attributional style for positive events compared to BPR, but did not significantly differ from CO.
Lex & Meyer (2009)	L	GP (196)	-	HPS, RIG	CSQ	Germany	HPS scores did not contribute to variance in attributional style for negative events. However, HPS scores did

Table 1. (continued)

Author (Date)	Design	Participants (N)	Adequate Power at 80%	Diagnostic Classification	Measure of Cognition	Location	Key Findings
Lomax et al. (2009)	C	BP (30) CO (30)	-	SCID	DAS	UK	predict global & stable attributions for positive events 2 yrs later. BP scored higher on DAS-A & DAS-D than CO. No significant group differences in DAS-GA or DAS-AD scores were observed.
Mansell et al. (2008)	C	GP (191)	-	HPS, MDQ	HAPPI	UK	Scores on the MDQ positively correlated with scores on the HAPPI.
Mansell et al. (2011)	C	BPR (14) BPRd (16) UP (22) HCO (16) CO (22)	-	SCID	DAS, HAPPI	UK	BPRd scored higher on the HAPPI compared to UP & CO, but did not significantly differ from HCO. No significant group differences in DAS score were observed.
Meyer et al. (2010)	C	GP (115)	-	SCID, HPS, BIS/BAS	CAQ	Germany	In the ability-based task, HPS scores predicted external attributions after success whereas BAS scores predicted a self-serving attributional style. In the chance-based task, HPS scores predicted a self-serving attributional style, but BAS scores did not significantly predict attributional styles.
Perich et al. (2011)	C	BP (90) UP (36) CO (66)	-	SCID, CIDI	DAS	Australia	BP scored higher on DAS-D & DAS-A than CO or UP. No significant group differences in DAS-GA scores.

Table 1. (continued)

Author (Date)	Design	Participants (N)	Adequate Power at 80%	Diagnostic Classification	Measure of Cognition	Location	Key Findings
Reilly-Hamington et al. (1999)	L	BP (49) UP (97) CO (23)	-	SADS-L, SADS-C, GBI, BDI	ASQ, DAS	USA	No significant group differences in ASQ or DAS scores were observed at Time 1. Only BP & UP with high DAS and/or ASQ-N scores, who also experienced a high number of NE, demonstrated an increase in depressive symptom scores from T1 to T2. BP with high ASQ-N scores, who also experienced a high number of NE, displayed an increase in symptoms of mania over time.
Reilly-Hamington et al. (2010)	C	BP (379)	-	MINI	ASQ, DAS	USA	BP in mixed or depressed episode demonstrated higher DAS scores than (hypo)manic and euthymic BP. DAS scores positively correlated with MADRS & YMRS scores. No significant group differences in ASQ-P were observed.
Scott et al. (2000)	C	BP (41) CO (20)	-	DSM-IV Criteria	DAS	UK	BP displayed higher DAS scores than CO.
Scott & Pope (2003)	C	BP (77) UP (16)	-	DSM-IV Criteria	DAS	UK	Depressed BP scored highest on the DAS followed by hypomanic BP, followed by BP in remission. No significant difference in DAS score between BP & UP were observed.
Strange et al. (2013a)	C	HR (171) CO (119)	-	SADS-L, BAS	DAS	USA	HR reported greater symptoms of hypomania, and scored higher on the HPS

Table 1. (continued)

Author (Date)	Design	Participants (N)	Adequate Power at 80%	Diagnostic Classification	Measure of Cognition	Location	Key Findings
Stange et al. (2013b)	L	HR (98) CO (63)	-	SADS-L, BAS	DAS	USA	HR scored higher on DAS than CO.
Thomas et al. (2009)	C	BP (55) CO (44)	-	ICD-10	SSCT	United Arab Emirates	Dysfunctional attitudes were higher in BP than CO during manic, depressive & euthymic periods. Dysfunctional attitudes did not significantly correlate with symptoms of depression or mania.
Wright et al. (2005)	C	BP (40) UP (40) CO (40)	-	SCID	DAS	UK	UP & CO demonstrated a greater reduction in DAS following the PMI, than BP. DAS scores did not significantly change in response to the NMI. However, a trend for higher DAS scores in response to the NMI was observed within the clinical groups. Those who had previously received CBT demonstrated a smaller increase in DAS after the NMI compared to those who had not previously received CBT.

Note: C= Cross-sectional; L= Intervention; L= Longitudinal; BP= Participants with Bipolar Disorder; UP= Participants with Unipolar Disorder; SZ= Participants with Schizophrenia; CO= Non-clinical Controls; HR= Participants at high behavioural-risk of bipolar disorder; MR= Participants at medium behavioural risk of bipolar disorder; UR= Participants at high behavioural-risk of unipolar disorder; GP= General population sample; FR= Participants at high familial-risk of bipolar disorder; CCO= Non-clinical child controls; BPH= Hypomanic Participants with Bipolar Disorder; BPR= Participants with Bipolar Disorder in Remission; BPRel= Participants with Bipolar Disorder who

have Relapsed with the last 2 years; HCO= Non-clinical Controls with a history of Hypomania; OCCPI= Operational Criteria Checklist for Psychotic Illness (McGuffin, Farmer & Harvey, 1991); SCAN= Schedules for Clinical Assessment in Neuropsychiatry (Wing, Babor, Brugha et al., 1990); RIG= Rigidity Scale of the Munich Personality Test (von Zerssen, Pfister & Koeller, 1988); MDQ= Mood Disorders Questionnaire (Hirschfeld, Williams, Spitzer et al., 2000); SADS-C= SADS-Change Version (Spitzer & Endicott, 1978); BDI= Beck Depression Inventory (Beck, Rush, Shaw & Emery, 1979); ISS= Internal States Scale (Bauer, Crits-Christoph, Ball et al., 1991); ISS-A= Activation subscale; ISS-PC= Perceived Conflict subscale; ISS-D= Depression subscale; ISS-WB= Well Being subscale; HIQ-H= Hypomanic appraisal subscale; HIQ-N= Normalising appraisal subscale; HIQ-E= Hypomanic Experience subscale; IDQ-D= Depressive appraisal subscale; NMI= Negative Mood Induction; PMI= Positive Mood Induction; DAS-A= Achievement subscale; DAS-GA= Goal-Attainment subscale; DAS-D= Dependency subscale; DAS-AD= Anti-Dependency subscale; DAS-PE= Performance Evaluation subscale; CT= Cognitive Therapy; TAU= Treatment As Usual; FU= Follow-Up; ASQ-N= Negative subscale; ASQ-P= Positive subscale; CES-D= Center for Epidemiological Studies Depression Scale (Radloff, 1991); MPC= Minimal Psychiatric Care; ME= Mood Episode; MRS= Mania Rating Scale (Bech, Rafaelsen, Kramp & Bolwig, 1978); SHPSS= Sense of Hyper-Positive Self Scale (Lam et al., 2005); NE= Negative Events; CBT= Cognitive Behavioural Therapy; MADRS= Montgomery-Asberg Depression Rating Scale (Montgomery & Asberg, 1979); YMRS= Young Mania Rating Scale (Young, Biggs, Ziegler & Meyer, 1978).

3.4.2 Methodological Limitations of Studies

Only 4 studies directly addressed the issue of power and sample size (Alatiq, Crane, Williams & Goodwin, 2010; Ball, Mitchell, Corry et al., 2006; Jones et al., 2005; Mansell, Paszek, Seal et al., 2011). The power calculation reported by one study, indicated that it was significantly under-powered to detect a moderate effect size (Ball et al., 2006). As lack of statistical power increases the likelihood of both Type I and Type II errors, this issue must be considered in light of the findings reported by Ball et al. (2006). Furthermore, as the majority of studies included in the present review did not report performing a formal power calculation, the statistical power offered by these studies should be regarded as uncertain.

In the majority of cases, the samples studied demonstrated a gender bias with a higher proportion of females to males. Three studies assessed majority male bipolar samples (Donohoe et al., 2012; Perich, Manicavasagar, Mitchell & Ball, 2011; Thomas et al., 2009), with one studying a 100% male non-clinical sample from the general population (Meyer et al., 2010). This issue may limit the generalizability of the findings given evidence that bipolar disorder affects males and females equally (Hendrick, Altshuler, Gitlin et al., 2000; Weissman, Leaf, Tischler et al., 1988). The lack of equal gender distribution in the samples studied may present a confound with regard to results related to attributional style in particular, as research suggests that males tend to demonstrate more stable, self-serving attributional styles than women (Deaux & Farris, 1977; Mezulis, Funasaki, Charbonneau & Hyde, 2010; Matud, 2004; Reno, 1981; Stake, 1990).

On the whole, studies assessing group differences in cognitive style were able to match groups on age and gender, with eight exceptions (Alatiq et al., 2010; Babakhani & Startup, 2012; Donohoe et al., 2012; Goldberg, Gerstein, Wenzel et al., 2008; Jones et al., 2005; Kelly, Mansell, Wood et al., 2011; Mansell et al., 2011; Thomas et al., 2009). In many cases, bipolar participants were significantly older than controls (Alatiq et al., 2010; Donohoe et al., 2012; Goldberg et al., 2008; Kelly et al., 2011; Mansell et al., 2011; Thomas et al.,

2009), which may have contributed to the overall pattern of stronger, stable, internalising attributions for negative events in bipolar samples as compared to controls (Lachman, 1990; Shine, 1997). However, the true impact of this age difference upon the validity of reported findings is unclear due to the lack of available evidence concerning relationships between age and cognitive style.

Just six studies compared groups on employment status (Alatiq et al., 2010; Ankers & Jones, 2009; Babakhani & Startup, 2012; Jones, Tai, Evershed et al., 2006a; Perich et al., 2011; Wright, Lam & Newsom-Davis., 2005), three reporting significant group differences (Alatiq et al., 2010; Jones et al., 2006a; Perich et al., 2011). Where significant group differences in employment status were reported, a larger proportion of bipolar participants were unemployed compared to non-clinical controls (Jones et al., 2006a; Perich et al., 2011), corroborating existing evidence of high unemployment in bipolar populations (see Marwaha, Durrani & Singh, 2013 for a review). Alatiq and colleagues (2010) compared groups in terms of percentage student and percentage employee, rather than comparing rates of unemployment. The authors observed a significantly higher proportion of students in the control sample compared to the bipolar and unipolar groups. Although research concerning the impact of employment status upon cognition is scarce, evidence regarding psychological correlates of unemployment indicates a positive relationship between unemployment and low self-esteem (Kokko & Pulkkinen, 1998). Therefore it is possible that the psychological impact of long-term unemployment could reinforce pessimistic cognitive styles, presenting a confounding factor in studies which do not match groups on employment status.

Only five studies addressed group differences in ethnicity (Goldberg et al., 2008; Jones et al., 2005; Reilly-Harrington, Alloy, Fresco & Whitehouse, 1999; Stange, Shapero, Jager-Hyman et al., 2013a; Stange, Boccia, Shapero et al., 2013b), all reporting non-significant differences between groups. Evidence of ethnic differences in appraisal (Bjorck, Cuthbertson, Thurman, & Lee, 2001), attribution (Birenbaum & Kraemar, 1995) and coping style (Sander, Davis, Struchen et al., 2007; Tan, Jensen, Thornby & Anderson, 2005)

emphasize the importance of controlling for ethnicity when assessing between-group differences in cognitive style. Therefore this issue should be kept in mind in light of results reported by studies which do not report the ethnic characteristics of the samples studied.

Of the twelve studies to compare cognitive styles in bipolar disorder with those of similar clinical comparison groups, only five studies reported information regarding age at illness onset (Alatiq et al., 2010; Jones et al., 2005; Lam, Wight & Smith, 2004; Lam, Wright & Sham, 2005; Scott & Pope, 2003). All five studies reported non-significant differences in age at onset between the clinical groups, reducing the possibility that any observed differences in cognitive style were purely related to illness severity rather than due to actual differences between diagnoses.

Studies which reported findings regarding cognitive styles in populations at behavioural high-risk for bipolar disorder, studied either majority or 100% student samples. It has been suggested that significant changes in psychosocial development take place during university studies, with recent evidence reporting changes in thinking styles during this period (Lairio, Puukari & Kuovo, 2013). Therefore it is unclear exactly how representative undergraduate student samples are of the general behavioural high-risk population, particularly where assessment of cognitive style is involved.

Seven of the eleven behavioural high-risk studies did not obtain any diagnostic information regarding past or present mental health diagnoses (Dempsey, Gooding & Jones, 2011; Dodd, Mansell, Morrison & Tai, 2011b; Johnson & Jones, 2009; Jones & Day, 2008; Knowles, Tai, Christensen & Bentall, 2005; Mansell et al., 2008). This is a significant limitation as, without this information, it is unclear what severity of risk the samples studied represent (i.e. individuals with previous episodes of depression may be at higher risk of bipolar disorder than individuals without).

The two intervention studies identified in the present review, reported follow-up periods of 6 and 12 months (Lam et al., 2005; Ball et al., 2006 respectively). Whilst it is

important to assess the effects of therapy during this time, these semi-longitudinal designs do not offer any insights into whether certain aspects of therapy are more useful than others in facilitating long-term change.

3.4.3 Relationship between Appraisals of Hypomanic and Depressive Experiences and Risk for Bipolar Disorder

Five studies reported findings regarding relationships between appraisals of hypomanic and/or depressive experiences, and behavioural high-risk for bipolar disorder (Jones et al., 2006b; Jones & Day, 2008; Ankers & Jones, 2009; Johnson & Jones, 2009; Dempsey et al., 2011). Ankers and Jones (2009) found that individuals classed as high-risk based upon their scores on the HPS, scored significantly higher on the HIQ-H than non-clinical controls exhibiting low HPS scores. Conversely, group comparisons with non-clinical controls and adolescents at familial high-risk of bipolar disorder, indicate a lack of significant differences in HIQ-H score (Espie et al., 2012).

Studies which performed regression analyses indicate that scores on the HIQ-H significantly contribute to scores on the HPS in both behavioural and familial high-risk populations (Jones et al., 2006b; Jones & Day, 2008; Ankers & Jones, 2009; Dempsey et al., 2011; Espie et al., 2012). Johnson and Jones (2009) conducted a factor analysis on a range of cognitive style and impulsivity measures, including the HIQ-H and HIQ-N. One of the factors represented overly positive attributions for symptoms of hypomania, based upon items from the HIQ-H, and was found to correlate positively with scores on the HPS (Johnson & Jones, 2009). Studies which assessed the contribution of scores on the IDQ-D to variation in HPS scores, reported non-significant effects (Jones & Day, 2008; Dempsey et al., 2011).

Four studies reported non-significant relationships between scores on the HPS and scores on the normalising subscales of the HIQ and IDQ (Jones & Day, 2008; Ankers & Jones, 2009; Johnson & Jones, 2009; Dempsey et al., 2011). Jones and Day (2008) also found

that neither the IDQ-N nor the HIQ-N significantly contributed to scores on the HPS on the basis of a regression analysis.

Only one study assessed appraisal styles in clinical bipolar individuals, exploring the relationship between mood symptoms and appraisals of hypomanic experiences (Dodd et al., 2011a). Neither scores on the HIQ-H, nor HIQ-N, significantly correlated with symptom severity, suggesting that such appraisal styles are not significantly related to bipolar mood symptoms.

3.4.4 Attributional Style

3.4.4.1 Relationships between Attributional Style and Risk for Bipolar Disorder

Three studies assessed attributional styles in individuals considered to be at high behavioural risk for developing bipolar disorder (Bentall et al., 2011; Lex & Meyer, 2009; Meyer et al., 2010). In a prospective investigation, Lex and Meyer (2009) found HPS scores were positively predictive of more stable and global, but not internal, attributions for positive events two years later. However, HPS scores were not significantly predictive of attributional styles for negative events.

Bentall and colleagues (2011) compared attributional styles for daily positive and negative events in individuals at low, medium and high risk for bipolar disorder based upon their scores on the HPS. The authors did not observe any significant differences in attributional style between the three groups, for either positive or negative events. It is possible that the study was underpowered to detect statistically significant differences in attributional style (see Table 1). However we were unable to explore this issue fully due to the manner in which attributional styles were assessed in this study compared to similar investigations.

Meyer et al. (2010) assessed relationships between attributional style and two separate indicators of behavioural risk for bipolar disorder; the HPS and the BAS. Meyer et al. (2010) assessed concurrent cognitive styles by asking participants to attribute their success after chance-based and ability-based tasks. In the chance-based task, HPS scores were found to be predictive of a self-serving attributional style, reflecting high personal relevance, internality, globality and stability. Scores on the BAS however, were not significant predictors of cognitive style for chance-based success. Conversely in the ability-based test, scores on the BAS were predictive of a self-serving cognitive style after success, whereas HPS scores were predictive of external attributions for success.

Only one study assessed attributional styles in individuals at familial high-risk of bipolar disorder (Espie et al., 2012). The authors reported non-significant differences in attributional styles for both positive and negative events, between familial high-risk and control individuals.

3.4.4.2 Attributional Styles in Euthymic Bipolar Populations versus Non-Clinical Controls

Three studies reported non-significant differences in internal and external attributions for both positive and negative events, between individuals with bipolar disorder and non-clinical controls (Reilly-Harrington et al., 1999; Lex, Hautzinger & Meyer, 2011; Donohoe et al., 2012). However, Knowles, Tai, Jones and colleagues (2007) found that whilst controls tended to make more internal attributions for positive events than they did negative events, remitted bipolar individuals tended to make more internal attributions for negative events than positive events, demonstrating a more pessimistic attributional style. The study carried out by Knowles et al. (2007) differs from the other three in that the results are based upon an implicit measure of attributional style, known as the Pragmatic Inference Task (PIT; Winters & Neale, 1985). The task was presented to participants as a memory test, disguising the true nature of the study. It is possible that explicit assessments of attributional style, such as the ASQ, may

reflect overarching, schema-like cognitions whilst implicit assessments may reflect more immediate, reactive cognitions such as the associative appraisals described by Power and Dalgleish (1997).

3.4.4.3 Relationship between Attributional Style and Mood in Bipolar Disorder

Three studies assessed attributional styles in bipolar individuals during different clinical states (Reilly-Harrington et al., 1999; Reilly-Harrington, Miklowitz, Otto et al., 2010; Lex et al., 2011). Reilly-Harrington and colleagues (1999) explored the interaction between attributional styles and stressful life events in predicting symptoms of mania and depression. Individuals were assessed at two time points, between two weeks and four months apart. Reilly-Harrington and colleagues (1999) observed a significant interaction between negative attributional style at time 1 and number of stressful life events experienced at time 2, in predicting change in both depressive and manic symptom scores. After controlling for the main effects of attributional style and life events, the interaction term accounted for 4.2 % of the variance in depressive symptom change and 10% of the variance in manic symptom change. Only those individuals who exhibited a negative attributional style, in addition to experiencing a high number of stressful life events, demonstrated an increase in both depressive and manic symptom scores (Reilly-Harrington et al., 1999). A later study by Reilly-Harrington et al. (2010) also found significant relationships between negative attributional style and mood symptoms, such that attributing negative events internally, stably and globally, correlated positively with both manic and depressive symptom severity. However, positive attributional styles (i.e. internal, global and stable attributions for positive events) were not significantly associated with symptoms of mania or depression (Reilly-Harrington et al., 2010).

Reilly-Harrington et al. (1999) also assessed correlations between attributional styles and clinical status at time 1. The authors observed significantly stronger negative attributional

styles in individuals who were currently depressed, compared to those experiencing episodes of mania, hypomania and euthymia. In terms of attributions for positive events, depressed individuals exhibited much weaker positive attributional styles than individuals experiencing episodes of mania, hypomania or euthymia. Whilst Reilly-Harrington et al. (1999) did not observe significant differences in positive attributional styles between hypomanic and euthymic individuals, Lex et al. (2011) observed much stronger positive attributional styles in individuals who were currently hypomanic compared to those who were euthymic. However, the two studies do converge on the lack of significant differences in attributions for negative events between hypomanic and euthymic individuals (Reilly-Harrington et al., 1999; Lex et al., 2011).

Only one study assessed attributional styles during mixed states (Reilly-Harrington et al., 2010), reporting significantly stronger negative attributional styles in mixed participants compared to euthymic participants. Unlike the other two studies, Reilly-Harrington and colleagues (2010) did not observe significant differences in attributional style during episodes of depression, euthymia, or mania. This contradictory pattern of results may be related to low statistical power (see Table 1.), however it was not possible to compare effect sizes between the three studies, as only Lex et al. (2011) reported the means and standard deviations of scores on the ASQ as a function of clinical status.

3.4.4.4 Comparison of Attributional Styles in Bipolar Disorder versus Other Conditions

Two studies compared attributional styles in bipolar disorder versus unipolar disorder (Reilly-Harrington et al., 1999; Knowles et al., 2007), reporting similar attributional styles for both positive and negative events. Lex and Meyer (2009) assessed relationships between attributional style and behavioural-risk for unipolar disorder in a non-clinical population. Whilst behavioural unipolar-risk was not significantly related to attributional styles for negative events, the authors found unipolar-risk to be significantly predictive of an optimistic

attributional style for positive events two years later. Whilst this pattern of findings somewhat contradicts existing literature on attributional styles in unipolar risk groups (Alloy, Abramson, Whitehouse et al., 2006), individuals who exhibit high levels of rigidity have also been shown to demonstrate a tendency to adhere to social norms (von Zerssen et al., 1997). Therefore it is possible that the unipolar-risk participants gave over-positive responses to the positive event items, in line with how they thought they should respond according to social norms.

Only one study was identified which compared the attributional styles of individuals with bipolar disorder and schizophrenia (Donohoe et al., 2012), again reporting no significant group differences in attributions for positive or negative events.

3.4.5 Extreme, Conflicting Appraisals of Internal States

3.4.5.1 Relationship between Extreme, Conflicting Appraisal Styles and Behavioural-Risk for Bipolar Disorder

Three studies were identified which had explored relationships between behavioural risk for bipolar disorder and conflicting appraisals of internal states (Mansell et al., 2011; Mansell et al., 2008; Dodd et al., 2011b). Two studies reported positive associations between risk for bipolar disorder and scores on the HAPPI, indicating that multiple, extreme, conflicting internal appraisals of internal states may represent a vulnerability factor in bipolar disorder (Dodd et al., 2011b; Mansell et al., 2008). In a study comparing HAPPI scores between non-clinical controls and non-clinical individuals with a history of hypomania, Mansell et al. (2011) observed significant group differences with the non-clinical hypomanic sample demonstrating higher Success-Activation, Activating Response Style, and Loss of Control subscale scores. These findings suggest that non-clinical individuals who have previously experienced hypomania, and therefore may be regarded as at-risk for developing bipolar disorder, exhibit stronger maladaptive beliefs around internal states compared to non-clinical controls.

3.4.5.2 Comparison of Extreme, Conflicting Appraisals in Euthymic Bipolar Populations versus Non-Clinical Controls

Three studies assessed the presence of extreme, conflicting appraisals of internal states in euthymic individuals with bipolar disorder compared to non-clinical controls (Alatiq et al., 2010; Kelly et al., 2011; Mansell et al., 2011). Two studies reported significant group differences in HAPPI scores, with bipolar individuals demonstrating higher scores than non-clinical controls (Alatiq et al., 2010; Mansell et al., 2011). Mansell et al. (2011) compared “recovered” bipolar individuals (i.e. those who had not experienced a relapse in the past two years and also remained well 6 months following the collection of the data), relapsed bipolar individuals (i.e. those who had relapsed within the past 2 years), non-clinical controls and non-clinical individuals who had a history of hypomania, on HAPPI subscale scores. Relapsed bipolar individuals scored significantly higher on all HAPPI subscales compared to the non-clinical controls. Recovered bipolar individuals scored significantly higher than the controls on all subscales apart from the Activating Response Style subscale. Recovered bipolar individuals did not differ significantly from the non-clinical individuals with a history of hypomania. The relapsed bipolar individuals only differed from the non-clinical individuals with a history of hypomania on the Catastrophic subscale of the HAPPI, indicating stronger excessively negative beliefs about internal states.

Kelly and colleagues (2011) divided the items of the HAPPI into positive and negative appraisals, to explore the ability of the HAPPI to distinguish between individuals with and without bipolar disorder. Kelly et al. (2011) found that the highest likelihood of bipolar disorder reflected high negative and high positive appraisals of internal states, whereas the lowest likelihood of bipolar disorder reflected low negative and high positive appraisals of internal states.

3.4.5.3 Relationship between Extreme, Conflicting Appraisals of Internal States and Mood Symptoms in Bipolar Disorder

Only one study was identified which assessed the relationship between conflicting appraisals of internal states and symptoms of bipolar disorder (Dodd et al., 2011a). All factors of the HAPPI positively correlated with activated states, as assessed using the Internal States Scale (ISS; Bauer, Crits-Christoph, Ball et al., 1991). The only factor significantly associated with symptoms of depression was the Loss of Control factor. Comparing baseline scores on the HAPPI, HIQ, BIS and BAS, Dodd et al. (2011a) found total scores on the HAPPI to be the only significant predictor of ISS-Activation ($\beta=0.51$) at four weeks. Total HAPPI scores did not significantly contribute to ISS-Depression.

Dodd et al. (2011a) also examined prospective relationships between each separate HAPPI factor and symptom scores at four weeks. ISS-Activation was significantly predicted by Activating Response Style ($\beta=0.53$), whilst ISS-Depression was significantly predicted by Loss of Control ($\beta=0.75$) and Success-Activation ($\beta=-0.68$). However, as the clinical status of participants was only assessed at baseline, it is possible that some participants were no longer euthymic when assessed four weeks later. This calls into question the validity of the findings as changes in clinical state are strongly linked to changes in symptom severity.

3.4.5.4 Comparison of Extreme, Conflicting Appraisals of Internal States in Bipolar Disorder versus Unipolar Disorder

Three studies compared bipolar and unipolar individuals on the tendency to form multiple, conflicting appraisals of internal states, as measured using the HAPPI (Alatiq et al., 2010; Kelly et al., 2011; Mansell et al., 2011). Individuals with bipolar disorder were found to score higher on the HAPPI as compared to unipolar individuals (Alatiq et al., 2010; Mansell et al., 2011). Furthermore, Kelly and colleagues (2011) reported that individuals with bipolar

disorder were more likely to exhibit a combination of strong positive and strong negative appraisals for internal states than individuals with unipolar disorder.

One study assessed multiple, conflicting appraisals of internal states in non-clinical individuals at behavioural high-risk of bipolar disorder and non-clinical individuals at behavioural high-risk of unipolar disorder (Dodd et al., 2011b). The authors did not observe any significant differences in HAPPI score between the two groups. However, there was a non-significant observation of higher HAPPI scores in the bipolar-risk group compared to the unipolar-risk group, raising the possibility that this study was under-powered to detect significant differences in HAPPI score between the two groups. Unfortunately it was not possible to explore this issue due to the lack of available comparison studies of unipolar-risk groups. The unipolar-risk group studied by Dodd and colleagues (2011b) also reported high levels of past hypomania. Therefore it is possible that the distinction of the risk groups based upon GBI scores alone was insufficient in correctly classifying unipolar and bipolar high-risk individuals. This may account for the lack of significant differences in conflicting appraisals between the two groups.

3.4.6 Dysfunctional Attitudes

3.4.6.1 Relationship between Dysfunctional Attitudes and Risk for Bipolar Disorder

Two studies were identified which had assessed dysfunctional attitudes in individuals at familial high-risk for bipolar disorder, reporting no significant differences in DAS scores between the high-risk individuals and non-clinical controls (Jones et al., 2006a; Jabben, et al., 2012).

Eight studies reported findings regarding the relationship between dysfunctional attitudes and behavioural high-risk for bipolar disorder (Bentall et al., 2011; Chen & Johnson, 2012; Knowles et al., 2005; Jones et al., 2006b; Jones, Shams & Liversidge, 2007; Mansell et

al., 2011; Stange et al., 2013a; 2013b). Of these studies, six reported significant, positive relationships between behavioural high-risk and dysfunctional attitudes (Bentall et al., 2011; Chen & Johnson, 2012; Jones et al., 2006b; Knowles et al., 2005; Stange et al., 2013a; 2013b). Furthermore, Jones et al. (2006b) found DAS (Weissman & Beck, 1978) scores significantly contributed to the variance in HPS scores. However, it is important to note that Stange and colleagues (2013a) only observed a predictive relationship between behavioural bipolar risk and DAS Performance Evaluation subscale scores. The relationship between behavioural high-risk and scores on the DAS Approval subscale was not significant. It is also important to note that the findings reported by Chen and Johnson (2012) are based on DAS Goal Attainment and DAS Achievement rather than total DAS.

Jones et al. (2007) did not observe significant relationships between behavioural high-risk for bipolar disorder and dysfunctional attitudes. Similarly, Mansell et al. (2011) observed no significant differences in total DAS, or any DAS subscale, scores between non-clinical controls with a history of hypomania, and non-clinical controls without history of hypomania. It is possible that the two studies were under-powered to detect statistically significant relationships between behavioural high-risk for bipolar disorder and dysfunctional attitudes, particularly as both studies demonstrated non-significant trends in the expected direction, and those studies which did observe significant relationships reported relatively small correlations (i.e. correlation coefficients ranging from .12 to .22).

An alternative explanation for the conflicting findings may relate to the severity of the high-risk samples studied. Bentall and colleagues (2011) found that, of the 26 high-risk individuals interviewed, 7 met criteria for cyclothymia, 4 met criteria for brief hypomania with brief depression, 3 met criteria for brief hypomania with previous major depressive episode, and 5 met criteria for bipolar disorder. Therefore the majority of high-risk individuals studied by Bentall et al. (2011) may not be representative of the general high-risk population, but may actually represent individuals exhibiting clinically significant symptoms of bipolar disorder who are yet to be identified by services. This is corroborated by the fact that 12 high-

risk individuals declined to take part in the study due to mental health problems (Bentall et al., 2011). It is possible that the five studies which also reported significant relationships between behavioural risk and dysfunctional attitudes, also studied individuals at the high end of the behavioural bipolar-risk spectrum.

Two studies assessed relationships between behavioural high-risk for bipolar disorder and dysfunctional attitudes in relation to symptoms of bipolar disorder (Bentall et al., 2011; Stange et al., 2013b). Bentall and colleagues (2011) observed that individuals who possessed high HPS in addition to high DAS (i.e. total DAS scores above 142), exhibited higher levels of bipolar symptoms and greater variability in self-esteem and negative affect compared to individuals who exhibited high HPS scores and DAS scores below 120. Whilst scores on both the HPS and the DAS significantly predicted broad bipolar spectrum diagnoses, only HPS scores significantly predicted narrow bipolar spectrum diagnoses. Stange et al. (2013b) found that DAS scores interacted with BAS-defined risk for bipolar disorder in predicting depressive symptom scores at follow-up (i.e. an average of 274 days from baseline).

3.4.6.2 Comparison of Dysfunctional Attitudes in Euthymic Bipolar Populations versus Non-Clinical Controls

Studies which assessed Goal-Attainment attitudes converged on the lack of significant differences between euthymic bipolar individuals and controls (Alatiq et al., 2010; Jabben et al., 2012; Lomax, Barnard & Lam, 2009; Mansell et al., 2011; Perich et al., 2011; Wright et al., 2005). The two studies which assessed Anti-Dependency attitudes also reported non-significant differences between bipolar and control individuals (Alatiq et al., 2010; Lomax et al., 2009).

Results regarding total DAS scores, and scores on the other DAS subscales, are mixed. Scott, Stanton, Garland and Ferrier (2010) reported higher Approval subscale scores in euthymic bipolar individuals as compared to non-clinical controls. Three studies observed

significantly higher Dependency subscale scores in euthymic bipolar individuals as compared to controls (Jones et al., 2005; Lomax et al., 2009; Perich et al., 2011). Conversely, four similar studies did not observe significant group differences in Dependency attitudes (Alatiq et al., 2010; Jabben et al., 2012; Mansell et al., 2011; Wright et al., 2005).

Potential methodological reasons for the conflicting findings are not immediately clear, however, it is possible that the differing results are related to the matching of groups on employment status. As Dependency attitudes relate to the need for validation from others, it is possible that such attitudes are higher in individuals who are unemployed compared to individuals in employment, as they may feel less independent and possess lower levels of self-efficacy and self-confidence (De Witte, Rothmann & Jackson, 2012; Suzuki, Amagai, Shibata & Tsai, 2011). Therefore higher rates of unemployment in the bipolar groups as compared to the control groups, may contribute to significant differences in Dependency attitudes. However, as the majority of studies did not report group comparisons in employment status, we were unable to test this hypothesis more thoroughly.

Conflicting findings were also reported regarding group differences in scores on the Achievement subscale of the DAS. Four studies reported significantly higher levels of Achievement attitudes in euthymic bipolar individuals as compared to controls (Jabben et al., 2012; Jones et al., 2005; Lomax et al., 2009; Perich et al., 2011), whereas three similar studies did not observe significant group differences (Alatiq et al., 2010; Mansell et al., 2011; Wright et al., 2005). Comparison of all seven studies did not highlight any consistent differences in methodology.

Studies comparing euthymic bipolar individuals and controls on total DAS scores, tended to report non-significant differences between the two groups (Alatiq et al., 2010; Jones et al., 2006a; Lex et al., 2008; Lex et al., 2011; Mansell et al., 2011; Wright et al., 2005). However, two studies observed significantly higher total DAS scores in euthymic bipolar

individuals (Jones et al., 2005; Scott et al., 2000). Possible explanations for the conflicting findings remain unclear.

Only one study was identified which assessed dysfunctional attitudes indirectly (Thomas et al., 2009), with the use of a sentence stem completion task (Teasdale, Taylor, Cooper et al., 1995). Participants were instructed to complete sentences with either positive or negative phrases (i.e. where use of positive phrases is indicative of dysfunctional attitudes). Thomas et al. (2009) found that euthymic bipolar individuals made significantly more positive responses than the non-clinical controls, demonstrating significantly higher levels of dysfunctional attitudes.

3.4.6.3 Relationship between Dysfunctional Attitudes and Clinical Status in Bipolar Disorder

Nine studies assessed dysfunctional attitudes across different clinical states (Goldberg et al., 2008; Jabben et al., 2012; Johnson & Fingerhut, 2004; Lex et al., 2011; Mansell et al., 2011; Reilly-Harrington et al., 1999; 2010; Scott & Pope, 2003; Thomas et al., 2009). Three studies observed significantly higher DAS scores in depressed bipolar individuals as opposed to euthymic individuals (Jabben et al., 2012; Reilly-Harrington et al., 2010; Scott & Pope, 2003). Elevated DAS scores were also observed in depressed individuals compared to hypomanic individuals in two studies (Reilly-Harrington et al., 2010; Scott & Pope, 2003). However, an earlier investigation did not observe significant differences in DAS score as a function of depressive status (Reilly-Harrington et al., 1999). It is possible that this earlier investigation was under-powered to detect statistically significant differences in DAS score as only 7 depressed and 5 manic/hypomanic individuals took part. However, we were unable to compare effect sizes between the studies due to the absence of reported means and standard deviations in each bipolar sub-group studied by Reilly-Harrington et al. (1999).

Mixed findings were also reported regarding dysfunctional attitudes during periods of hypomania versus periods of euthymia. Scott and Pope (2003) reported significantly higher

DAS scores in hypomanic individuals compared to remitted bipolar individuals, whereas two similar studies did not observe significant group differences (Lex et al., 2011; Reilly-Harrington et al., 2010). All three studies assessed similar numbers of hypomanic participants and reported similar gender ratios within the samples. However, the average DAS scores reported by Scott and Pope (2003) are considerably higher than those reported by the other two studies, in both the hypomanic and remitted bipolar samples. Examination of the ISS (Bauer et al., 1991) symptom scores in the bipolar sample as a whole, indicate that the sample was depressed overall (i.e. average ISS-WB score <125). The BDI (Beck et al., 1979) scores reported by Lex et al. (2011) indicate that both the hypomanic and remitted bipolar groups were experiencing minimal depressive symptoms. Therefore it is possible that the higher DAS scores observed by Scott and Pope (2003) are related to higher levels of depressive symptoms within their bipolar sample as compared to the other two studies. As Reilly-Harrington et al. (2010) did not report levels of depressive symptomatology in the bipolar sample, we were unable to draw comparisons with this study.

The results of Thomas et al. (2009), who assessed dysfunctional attitudes indirectly, indicate that dysfunctional attitudes do not differ significantly between periods of mania, depression or euthymia. However this study may have been under-powered to detect significant differences between the euthymic individuals and the other two groups (see Table 1.). As no information is given regarding how the bipolar participants were recruited, we also cannot rule out the possibility that the sample studied by Thomas and colleagues (2009) exhibited lower illness severity in comparison to the samples studied by direct means.

Only one study reported findings relating to dysfunctional attitudes during mixed episodes (Reilly-Harrington et al., 2010). The authors reported significantly higher DAS scores in individuals exhibiting a mixed state compared to individuals who were currently manic, hypomanic or euthymic. However, those in a mixed state did not differ significantly from depressed bipolar individuals (Reilly-Harrington et al., 2010). These results support the notion that dysfunctional attitudes are more strongly related to symptoms of depression than

mania in bipolar disorder (Johnson & Fingerhut, 2004; Lam et al., 2004), as mixed episodes are characterised by significant symptoms at both polarities (American Psychological Association, 2000).

Studies which considered the relationship between previous mood episodes and dysfunctional attitudes, indicate a non-significant relationship. Johnson and Fingerhut (2004) reported non-significant relationships between DAS score and the number of previous episodes of either mania or depression reported. Similarly Mansell et al. (2011) reported no significant differences in dysfunctional attitudes between bipolar individuals who had relapsed within the past two years, and bipolar individuals who had not experienced a relapse during this time.

3.4.6.4 Relationship between Dysfunctional Attitudes and Symptoms in Bipolar Disorder

Ten studies reported findings regarding the relationship between dysfunctional attitudes and symptoms of mania and depression in bipolar disorder (Goldberg et al., 2008; Johnson & Fingerhut, 2004; Jones et al., 2005; Lam et al., 2004; Lee, Lam, Mansell & Farmer, 2010; Lex et al., 2011; Reilly-Harrington et al., 1999; 2010; Scott et al., 2010; Thomas et al., 2009). Five studies reported significant, positive relationships between depressive symptom scores and DAS scores (Johnson & Fingerhut, 2004; Lam et al., 2004; Lee et al., 2010; Reilly-Harrington et al., 1999; 2010). However, Lam and colleagues (2004) only observed significant relationships between depressive symptom scores and scores on the Dependency subscale of the DAS. Scores on the Achievement and Goal-Attainment subscales were not significantly associated with symptoms of depression (Lam et al., 2004). Furthermore, Reilly-Harrington et al. (1999) only observed significant relationships between dysfunctional attitudes and symptoms of depression when factoring in the effect of negative life events. Only those individuals who exhibited high levels of dysfunctional attitudes, in combination with a high number of negative life events, demonstrated an increase in

symptoms of depression from Time 1 to Time 2 (Reilly-Harrington et al., 1999). The authors found that DAS scores at Time 1 interacted with the number of negative life events recorded at Time 2 to significantly predict changes in depressive symptom scores after controlling for the separate effects of DAS score and number of negative events experienced. However, this interaction only accounted for 9.9% of the variance in depressive symptom change.

The two studies which did not observe significant relationships between dysfunctional attitudes and symptoms of depression, were also the two studies to assess bipolar samples consisting of mainly manic individuals, exhibiting low levels of depression (Goldberg et al., 2008; Thomas et al., 2009). Therefore, it is possible that the depressive symptoms experienced by the samples in these two studies may not have been severe enough to activate dysfunctional attitudes, in line with the DAH (Teasdale, 1988).

Evidence regarding the relationship between dysfunctional attitudes and symptoms of mania, is also mixed. Three studies did not observe any significant relationships between dysfunctional attitudes and symptoms of mania (Johnson & Fingerhut, 2004; Lam et al., 2004; Thomas et al., 2009). However, two similar studies reported significant, positive relationships between dysfunctional attitudes and symptoms of mania (Goldberg et al., 2008; Reilly-Harrington et al., 2010). It is possible that the findings reported by Goldberg et al. (2008) partly reflect the fact that the sample studied were experiencing significantly higher levels of mania in comparison to the other four studies. Underlying reasons for the conflicting findings reported by Reilly-Harrington and colleagues (2010) however, are not apparent. It is possible that the conflicting results are related to how manic symptoms were assessed. Whereas both Reilly-Harrington et al. (2010) and Goldberg et al. (2008) assessed symptoms of mania using the Young Mania Rating Scale (YMRS; Young, Biggs, Ziegler & Meyer, 1978), other studies measured symptoms of mania using the Bech-Rafaelsen Mania Scale (BRMS; Bech, Bolwig, Kramp, & Rafaelsen, 1979) and the ISS (Bauer et al., 1991). Subtle differences in the items covered by these scales (Bech, Gex-Fabry, Aubry et al., 2006) may contribute to the difference in reported findings. It is also important to note that the correlation between

dysfunctional attitudes and symptoms of mania reported by Reilly-Harrington et al. (2010) was rather weak ($r=.18$).

3.4.6.5 Relationship between Dysfunctional Attitudes and Induced Mood in Euthymic Bipolar Populations versus Non-Clinical Controls

Two studies explored relationships between dysfunctional attitudes and induced moods in euthymic bipolar individuals, and non-clinical controls (Babakhani & Startup, 2012; Wright et al., 2005). Babakhani and Startup (2012) observed that all DAS subscale scores, in addition to total DAS, were significantly higher after the negative mood induction compared to the positive mood induction in the bipolar group. However, Wright et al. (2005) did not observe significant differences in the bipolar sample DAS score between the negative and positive mood conditions.

Following the positive mood induction, Wright et al. (2005) observed a significantly greater change in total DAS score from baseline in the control group as compared to the bipolar group, with controls demonstrating a significant decrease in total DAS. However, between-group differences in the degree of change in DAS subscale scores between pre- and post-positive mood induction, did not reach significance. Following the negative mood induction, the difference between bipolar and control individuals in DAS total and subscale score change from baseline was not significant. These results suggest dysfunctional attitudes are more reactive to positive affect in control individuals compared to bipolar individuals. As Babakhani and Startup (2012) did not assess DAS scores at baseline, it was not possible to draw comparisons between the two studies.

Research suggests that film mood induction procedures are more effective than music mood induction procedures in eliciting positive mood states (Westermann, Spies, Stahl & Hesse, 1996), which implies that the positive moods induced by Wright et al. (2005) may have been more powerful than those produced by Babakhani and Startup (2012). However,

Wright et al. (2005) reported relatively small changes in mood as a result of the induction procedure. Furthermore, there is also evidence to suggest that the effects of mood induction procedures are strengthened when individuals are asked to try and achieve a particular mood state, as in the case of Babakhani and Startup (2012).

Regarding the induction of negative moods, there is evidence to suggest that the procedure administered by Babakhani and Startup (2012) produces stronger mood effects than the procedure administered by Wright and colleagues (2005; Van Der Does, 2002). Van Der Does (2002) also observed that both procedures produced stronger effects on dysfunctional attitudes, in individuals who had experienced previous episodes of depression compared to those who had never been depressed. As the bipolar participants studied by Babakhani and Startup (2012) reported a much higher mean number of previous depressive episodes (mean =12.73) compared to those studied by Wright et al. (2005; mean= 5.5), this may account for the difference in reported results regarding change in DAS score in the negative mood induction condition.

3.4.6.6 Comparison of Dysfunctional Attitudes in Bipolar Disorder versus Unipolar Disorder

Nine studies assessed the dysfunctional attitudes of individuals with bipolar disorder in comparison to individuals with unipolar disorder (Alatiq et al., 2010; Goldberg et al., 2008; Jones et al., 2005; Lam et al., 2004; Mansell et al., 2011; Perich et al., 2011; Reilly-Harrington et al., 1999; Scott & Pope, 2003; Wright et al., 2005), six of which reported no significant difference in total DAS score (Alatiq et al., 2010; Lam et al., 2004; Mansell et al., 2011; Reilly-Harrington et al., 1999; Scott & Pope, 2003; Wright et al., 2005). However, two studies observed significantly higher total DAS scores in unipolar individuals (Goldberg et al., 2008; Jones et al., 2005). None of the participants studied by Goldberg et al. (2008) were euthymic, with the unipolar sample meeting criteria for current depression and the bipolar sample meeting criteria for mania. Similarly, although the unipolar participants studied by

Jones et al. (2005) were deemed to be euthymic, they demonstrated clinically significant symptoms of depression which were significantly greater than those observed in the bipolar sample. Furthermore, no significant group differences were observed in total DAS or on any DAS subscale when current levels of depression were controlled for (Jones et al., 2005). Therefore it is possible that in both cases, the higher levels of depression in the unipolar participants, activated stronger dysfunctional attitudes compared to the bipolar participants, in line with the DAH (Teasdale, 1983, 1988).

The five studies to compare Goal-Attainment attitudes in bipolar versus unipolar individuals all reported non-significant group differences (Alatiq et al., 2010; Lam et al., 2004; Mansell et al., 2011; Perich et al., 2011; Wright et al., 2005). However, after excluding individuals who met criteria for a current mood episode (i.e. 75% of unipolar sample, 63.7% of bipolar sample) and controlling for current mood symptoms, Lam and colleagues (2004) observed significantly higher DAS Goal-Attainment scores in the bipolar group as opposed to the unipolar group. The authors also reported a significant positive correlation between DAS Goal-Attainment subscale scores and levels of depression in the unipolar sample, but not the bipolar sample, which may be related to the significantly higher levels of depression in the former group (Lam et al., 2004).

Four studies reported non-significant differences in Achievement and Dependency attitudes between bipolar and unipolar participants (Alatiq et al., 2010; Lam et al., 2004; Mansell et al., 2011; Wright et al., 2005). The only two studies to assess scores on the DAS Approval subscale also reported non-significant group differences (Goldberg et al., 2008; Scott & Pope, 2003). Whilst Jones et al. (2005) observed significantly higher scores on both the Achievement and Dependency subscales in the unipolar group as opposed to the bipolar sample, these differences became non-significant after controlling for current levels of depression. Conversely, Perich and colleagues (2011) observed significantly higher DAS Achievement and Dependency subscale scores in the bipolar sample compared to the unipolar sample, even after controlling for current symptoms of mania, depression and anxiety. In the

latter study, the unipolar and bipolar samples differed significantly regarding employment status, with a higher number of bipolar individuals classed as unemployed or retired compared to the unipolar participants. As mentioned previously, it is possible that group differences in employment status may contribute to differences in dysfunctional attitudes.

It is also important to note that Wright et al. (2005) observed a greater reduction in total DAS, DAS Achievement, and DAS Goal-Attainment scores from baseline to post-positive mood induction in the unipolar as opposed to the bipolar sample. These results indicate that whilst increases in positive affect served to reduce dysfunctional attitudes in the unipolar individuals, this effect was minimal in the bipolar sample. However, as Wright et al. (2005) point out, the observed changes in mood produced by the mood induction procedure were rather small and therefore may not have been sufficient to activate, or indeed dampen, dysfunctional attitudes in all participants.

Two studies reported contrasting findings regarding dysfunctional attitudes related to Self-Control (Jones et al., 2005; Lam et al., 2004). Whereas Jones et al. (2005) observed significantly higher subscale scores in individuals with unipolar disorder as opposed to bipolar disorder, Lam et al. (2004) reported findings in the opposing direction. However, after controlling for current levels of depression, the difference in Self-Control scores became non-significant in the former study (Jones et al., 2005).

Existing evidence also suggests that bipolar and unipolar individuals do not differ significantly in terms of dysfunctional attitudes related to Anti-Dependency and Perfectionism (Alatiq et al., 2010; Scott & Pope, 2003, respectively). One study examined group differences in DAS Performance (Goldberg et al., 2008), reporting significantly higher scores in unipolar depressed individuals as opposed to bipolar individuals who were currently manic. Goldberg et al. (2008) also observed significant positive correlations between scores on the DAS and scores on the Cognitive Checklist for Mania (CCL-M; Beck, Colis, Steer et al., 2006) in the bipolar, but not the unipolar, group. These preliminary results suggest that the cognitive

schemas linked to mania, assessed by the CCL-M (Beck et al., 2006), may be uniquely related to dysfunctional attitudes in bipolar disorder. However further replication of these findings is required.

3.4.7 Efficacy of Interventions which target Dysfunctional Attitudes

Only two studies were identified which assessed the efficacy of interventions designed to target maladaptive cognitions for individuals with bipolar disorder (Ball et al., 2006; Lam et al., 2005). Lam et al. (2005) compared a programme of cognitive therapy (CT) against 'minimal psychiatric care' (MPC) in 103 euthymic individuals meeting criteria for Bipolar I disorder, where MPC involved the prescription of mood stabilizers in addition to regular psychiatric follow-up. Ball et al. (2006) compared a 20-session programme of CT against 'treatment as usual' (TAU) within a sample of 52 individuals meeting criteria for Bipolar I or II disorder, where TAU represented brief psychoeducation, mood monitoring and regular review of medication. In both studies, participants who received the CT intervention did not differ significantly from those who were randomized to the non-experimental condition, regarding baseline DAS scores.

In both studies, individuals who had received CT demonstrated greater treatment effects compared to those randomised to the control condition. Lam et al. (2005) observed that individuals who had received CT, experienced fewer bipolar mood episodes, and also spent fewer days in episode, during the 6 month study period compared to those who received MPC. However, as Lam et al. (2005) did not re-assess dysfunctional attitudes post-treatment, it is not clear to what extent the positive treatment outcomes were related to improvements in these maladaptive cognitions. Ball et al. (2006) observed significantly lower levels of depression immediately following treatment in those who had received the CT intervention compared to those who had been randomised to TAU. As both groups did not differ significantly in terms of medication adherence, the results cannot be due to

psychopharmacological effects alone. However, at quarterly follow-up points the difference in depressive symptom scores between the groups became non-significant, suggesting a negative association between improvement in depressive symptoms and time from termination of therapy (Ball et al., 2006). A similar pattern was also observed regarding dysfunctional attitudes.

The results reported by Wright et al. (2005) also indicate that cognitive interventions may significantly impact upon dysfunctional attitudes in bipolar disorder. Although baseline DAS scores did not significantly differ between bipolar individuals who had, and individuals who had not, received cognitive behavioural therapy (CBT) in the past, those who had received CBT exhibited significantly smaller increases in DAS score following the negative mood induction compared to those who had not. When the authors examined this relationship following the high mood induction, no significant differences were found.

3.5 Discussion

3.5.1 Summary of the Findings

In the present review, we sought to critically appraise evidence regarding the role of cognitive styles in bipolar disorder.

The evidence reviewed indicates significant associations between positive, internal appraisal styles and behavioural high-risk for bipolar disorder. Although this appears to conflict with evidence concerning attributional styles in behavioural high-risk populations, the findings reported by Bentall et al. (2011) and Meyer et al. (2010) suggest that self-esteem may interact with behavioural bipolar-risk in determining cognitive styles. Ability-driven success may activate negative schemas representing core beliefs of low self-esteem (e.g. “I am a failure”) resulting in pessimistic attributions. Chance-related success however, may trigger positive schemas linked to thrill-seeking and reward (e.g. “The world is full of

opportunities”), causing self-serving attributional styles. This idea is supported by accumulating evidence of self-esteem instability in clinical bipolar and non-clinical familial high-risk populations (Jones et al., 2006a; Knowles et al., 2007).

Evidence concerning dysfunctional attitudes suggests that, whilst such attitudes are positively related to behavioural high-risk for broad bipolar spectrum disorders, these cognitions may interact with other factors in contributing to more severe forms of the disorder. These results lend support to Jones’ (2001) model of bipolar disorder which emphasizes the role of a trait-like circadian instability in vulnerable individuals.

In the present review, individuals at familial high-risk of bipolar disorder demonstrated similar cognitive styles to non-clinical controls. When viewed alongside evidence of cognitive styles in individuals at behavioural high-risk of bipolar disorder, the findings suggest that bipolar-relevant cognitions may be more strongly related to behavioural traits than familial traits. However, due to concerns regarding statistical power, in addition to an absence of similar investigations upon which to draw comparisons, further research into familial high-risk individuals will be required to test this assumption.

Evidence concerning conflicting, internal appraisals and attributional styles in clinical bipolar populations, indicates differences in explicit and implicit cognitions, lending support to multilevel cognitive approaches such as the Integrative Cognitive Model (Mansell et al., 2007) and Jones’ (2001) adapted SPAARS model. Preliminary evidence of an important interaction between attributional styles and life-events, adds further support to models which emphasize the role of circadian-rhythm disrupting events in the development of mood change, such as Jones’ (2001) approach.

Evidence regarding attributional styles and conflicting appraisals of internal states, suggests that negative cognitive styles are more strongly related to bipolar disorder than positive cognitions. Whilst this may appear to conflict with evidence of self-serving appraisal styles in behavioural high-risk populations, it is possible that cognitive tendencies change

over the course of the disorder, with negative appraisal styles becoming reinforced via adverse mood experiences as indicated by Beck (1967).

Although dysfunctional attitudes did not distinguish between individuals with and without bipolar disorder, preliminary evidence suggests that such attitudes predict symptoms of depression in behavioural high-risk groups. As the DAS was originally developed for use in individuals with unipolar depression, and thus reflects depressogenic cognitions, it is possible that this measure is unable to fully capture dysfunctional attitudes important in bipolar disorder. For example, the finding that euthymic bipolar and control individuals do not differ significantly in terms of attitudes relating to obtaining unrealistic goals, contrasts sharply with evidence of unrealistic goal-setting in bipolar populations (Johnson, 2005; Johnson, Eisner & Carver, 2009).

On the whole, individuals with bipolar disorder demonstrated similar cognitive styles to individuals with unipolar disorder, although further research is required to explore group differences in HAPPI scores. The available evidence suggests that aspects of maladaptive cognition may be transdiagnostic, and therefore a large proportion of the severe mental illness population may benefit from the same cognitive interventions designed to target such cognitions.

Cognitive interventions demonstrated positive, albeit short-term, effects for individuals with bipolar disorder in terms of relapse prevention, symptom reduction, and improving dysfunctional attitudes. When viewed together with evidence of DAS reactivity to negative mood in individuals who had versus individuals who had not previously received CBT (Wright et al., 2005), it would appear that cognitive interventions have a long-term, positive effect upon state-like but not trait-like dysfunctional attitudes. This would suggest that current cognitive techniques may not be powerful enough to change ingrained attitudes, providing limited utility in the long-term for individuals with bipolar disorder. However, due

to the lack of available evidence concerning the effects of cognitive interventions upon cognitive style, future research will need to explore this fully.

3.5.2 Directions for Future Research

The present review has highlighted the need for further research into a number of areas to improve current understanding of the role of cognitive styles in bipolar disorder. Whilst evidence concerning the role of dysfunctional attitudes in clinical bipolar populations is accumulating, relatively few investigations of appraisal style in clinical populations were identified in the present review. With available evidence pointing to positive associations between behavioural high-risk for bipolar disorder and internal appraisals of internal states, it is crucial that future research efforts explore the role of appraisal longitudinally so that comparisons may be drawn between cognitive styles before and after illness onset. Investigations of when cognitive styles become established in bipolar disorder will not only inform preventative interventions, but will also improve our understanding of the factors which interact with cognitive style in contributing to risk.

Investigation into cognitive styles within familial high-risk populations also demands further attention. If future research efforts replicate existing findings by demonstrating non-significant associations between maladaptive cognitive styles and familial high-risk of bipolar disorder, this will highlight the need for preventative cognitive interventions to focus on behavioural rather than familial high-risk individuals.

The present review has also highlighted a potentially significant distinction between explicit and implicit cognitive styles in bipolar disorder, which may represent the automatic versus schematic modes of cognitive processing outlined by Power and Dalgleish (1997). We therefore recommend that future studies explore this area more fully to inform current models of mood. Attempts to develop a measure which encapsulates these distinctive levels of processing may be beneficial to the field.

Although cognitive interventions for bipolar disorder are informed by models of cognition, we struggled to find studies which had assessed the impact of such interventions upon cognitive processing. Interventions based upon cognitive models of bipolar disorder must be assessed regarding the extent to which positive treatment outcomes relate to anticipated changes/improvements in cognitive processing. Such information will inform our current models of bipolar disorder and illuminate areas for further improvement.

In the current economic climate, providing clear and robust justification for the increased accessibility to psychological interventions is extremely important. Therefore it is crucial that studies examining the efficacy of psychological treatments, such as cognitive therapy, strive to employ longitudinal designs which follow-up participants years after the termination of therapy.

3.5.3 Limitations of the Review

In the present review, only studies available in English were included which may underlie a bias towards identification of studies conducted in the UK. As dissertation abstracts were also excluded, relevant findings from unpublished studies may have been missed. In the present review, the methodological quality of studies was assessed using the CASP tools for case-control studies and RCTs (Critical Appraisal Skills, 2010). Whilst the CASP tools have yet to be formally validated, the assessment of methodological quality is a controversial issue. Investigations into various quality assessment tools have demonstrated that the overall quality score given to a study can vary greatly depending on the tool used (Jüni, Witschi, Bloch & Egger, 1999).

3.5.4 Conclusion

On the whole, the available evidence supports multilevel cognitive models of mood which emphasize the internal interpretation of experiences, and are able to account for automatic as well as more protracted cognitive processes in bipolar disorder. Whilst we found evidence of positive relationships between internal, conflicting appraisal styles and behavioural risk for bipolar disorder, evidence concerning cognitive styles in clinical bipolar populations was lacking and inconsistent. We suggest this may be related to a lack of distinction between implicit and explicit cognitions, in addition to issues surrounding the specificity of the measures used to assess such cognitions in bipolar disorder. Contrary to previous reports (Jones et al., 2006b), emerging evidence indicates that negative cognitions play an important role in instigating bipolar mood change (Kelly et al., 2011). Whilst available evidence concerning cognitive interventions for bipolar disorder indicates that such approaches bring about short-term, positive treatment outcomes, the cognitive mechanisms underlying these outcomes remain unclear. Longitudinal investigations of the impact of such interventions upon cognitive styles are therefore required to assess the validity of current models of mood in bipolar disorder and thus inform clinical practice.

3.6 References

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Chapter 4: Overview and Justification of Methods

4.1 Rationale for the Current Research

The current research was motivated by several factors. Firstly, existing literature concerning circadian and social rhythm disturbances in bipolar disorder, and particularly how these disturbances relate to mood, is highly inconsistent. Secondly, evidence concerning cognitive styles in bipolar disorder suggests that internal appraisal styles may play a significant role. However research in this area is extremely lacking, particularly in clinical bipolar populations. Thirdly, the moderating role of appraisal style suggested by multilevel cognitive models of bipolar disorder, requires further examination to improve our currently limited understanding of how disturbances in circadian and social rhythms translate into mood change. Fourthly, it is unclear whether or not relationships between circadian and social rhythm instability, appraisal style and mood, are unique to bipolar disorder or reflective of chronic conditions in general.

Therefore, the studies outlined subsequently examined relationships between circadian and social rhythm instability, appraisal style and mood, in individuals with and without bipolar disorder. Individuals with fibromyalgia were studied alongside individuals with bipolar disorder due to similarities in chronicity and sleep disruption. As available evidence suggests potential differences in state versus trait rhythm disturbance in bipolar disorder, relationships between rhythm instability, appraisal style and mood were assessed at the state and trait level using a combination of self-report measures, actigraphy and experience sampling methodology.

4.2 Methodological Approaches

4.2.1 Overview

A combination of self-report and objective research methods were employed, within both cross-sectional and prospective designs. The methods and measures employed in each study are described in detail within the specific papers that follow. The current section is intended to provide a critique of the methods used, whilst also providing details of the development of specific measures.

In Study 1, individuals with bipolar disorder, individuals with fibromyalgia, and a large non-clinical sample from the general population, completed an online survey composed of validated measures relating to circadian and social rhythm instability, appraisal style and mood. From within the non-clinical sample, two study groups were identified on the basis of their scores on the HPS (Eckblad & Chapman, 1986); controls and individuals at behavioural high-risk for bipolar disorder.

In Study 2, individuals with bipolar disorder, individuals with fibromyalgia, and non-clinical controls took part in a seven day ecological assessment. Using experience sampling methodology (ESM), participants provided information in a paper and pencil diary regarding their current mood and appraisal style at semi-random moments over the course of each day. Participants were either given a beeping analogue watch, or received text messages to their mobile phone, signalling them to complete each diary entry throughout the study period. Participants completed the daily Social Rhythm Metric (SRM; Monk, Flaherty, Frank et al., 1990) to provide an indication of their social rhythm regularity, whilst sleep and activity rhythms were assessed using wrist-actigraphy and sleep logs.

Studies 1 and 2 were approved by the Lancaster North West National Health Service Research Ethics Committee, and were adopted by the Mental Health Research Network. The studies collected data that inform three separate PhD projects, therefore, only those methodologies relevant to the current thesis are described below.

4.2.2 Selection of Comparison Groups

To investigate the extent to which relationships between circadian and social rhythm instability, appraisal style and mood are unique to bipolar disorder, three comparison groups were selected for study.

A non-clinical sample, comprised of individuals without any current mental health problems, was selected to draw comparisons between non-clinical individuals and those with bipolar disorder on the key variables of interest. This would highlight any significant differences between individuals with bipolar disorder and non-clinical individuals, thus illuminating particular effects which may underlie mood change in bipolar disorder. To explore this relationship further, the non-clinical sample was separated into individuals considered to be at behavioural high-risk of developing bipolar disorder, and “healthy” controls. This would allow for the examination of rhythm instability and appraisal style as risk factors which contribute to the development of bipolar disorder in non-clinical populations.

In examining the extent to which relationships between circadian and social rhythm instability, appraisal and mood are specific to bipolar disorder, a third comparison group was included. It was important that this group suffered from a similarly chronic condition to bipolar disorder, with comparable severity of circadian and social rhythm disturbance. However, it was equally important that this group did not experience significant symptoms of (hypo)mania reflective of an undiagnosed bipolar disorder. These two criteria would enable comparison of the moderating effect of appraisal style between individuals who experience rhythm disturbance and extreme mood swings, and individuals who experience rhythm disturbance and “normal” fluctuations in mood. Furthermore, the addition of this group would allow for the investigation of whether any significant relationships observed in the bipolar sample were bipolar-specific or were more reflective of chronicity in general.

A number of chronic disorders were investigated as potential candidate study populations, including diabetes, chronic migraine, dystonia and fibromyalgia. Each condition

was researched to obtain information on key symptoms associated with the disorder, in addition to prevalence rates, evidence of genetic links and sociodemographic factors. Due to a number of shared similarities with bipolar disorder, including sleep disturbance severity (Lineberger, Means & Edinger, 2007; Landis, Frey, Lentz et al., 2003; Bigatti, Hernandez, Cronan & Rand, 2008; Moldofsky, 2008; Stuifbergen, Phillips, Carter et al., 2010; Hamilton, Atchley, Karlson et al., 2012; Mork & Nilsen, 2012), rates of employment (Reisine, Fifield, Walsh & Feinn, 2003; Henriksson, Leidberg & Gerdle, 2005), prevalence (Wolfe, Ross, Anderson et al., 1995; Lindell, Bergman, Petersson et al., 2000; Neumann & Buskila, 2003), genetic links (Buskila, Neumann, Hazanov & Carmi 1996; Smith, Maixner, Fillingim et al., 2012) and poor concentration and memory impairment (Glass, 2010; Schmidt-Wilcke, Wood & Lürding, 2010; Williams, Clauw & Glass, 2011), a decision was made to focus on individuals with fibromyalgia. Fibromyalgia is a musculoskeletal chronic pain condition, characterised by severe sleep disturbance, memory impairment and fatigue (Chakrabarty & Zoorob, 2007).

Preliminary evidence of high comorbidity between fibromyalgia and bipolar disorder further indicated that this population would be well suited as a comparison group, as this suggests the presence of shared underlying commonalities between the two conditions (Hudson, Arnold, Keck et al., 2004; Arnold, Hudson, Hess et al., 2004; Arnold, Hudson, Keck et al., 2006). For example, Arnold et al. (2004) reported a comorbid diagnosis of bipolar I disorder in 1.3% of their fibromyalgia sample using the SCID (First et al., 1997), with 11.5% of the sample meeting SCID criteria for bipolar II disorder.

4.2.3 Online Surveys

Online survey studies are an effective means of reaching populations which may be stigmatized offline, such as individuals with bipolar disorder or fibromyalgia (Wright, 2005). Individuals who experience stigma around their condition may feel uncomfortable discussing it, and the issues surrounding it, face-to-face. Online surveys overcome this issue as they reduce the experimenter effect and have also been shown to reduce social desirability, improving the validity and reliability of responses (Rhodes, Bowie & Hergenrather, 2003). Therefore this methodology is ideally suited to studies aimed at obtaining information regarding underlying psychological processes in both clinical and non-clinical populations.

Online surveys are also beneficial in practical terms as they permit potential for recruitment of large, global samples and yet do not involve common study costs associated with travel, equipment and phone calls (Wright, 2005). Online surveys offer a means of obtaining representative samples of individuals from various geographical locations and socioeconomic backgrounds (Rhodes et al., 2003). Therefore the results of an online survey may be more generalizable to the wider population, than a paper and pencil survey carried out within one region.

Whilst the distance between participant and researcher in online survey studies may be beneficial in terms of reducing social desirability and improving honesty, there are a number of disadvantages associated with this format. The lack of direct contact between the participant and researcher raises ethical issues around informed consent, as it is unclear whether or not the participant has fully understood the nature and purpose of the study before consenting to take part (Rhodes et al., 2003). In a face-to-face setting, the researcher can answer any questions the participant may have immediately, and can also gauge reactions to potentially distressing questions and offer support where necessary. This is not feasible in the case of online surveys. In the study outlined subsequently, those who completed the survey were presented with details of supportive services they may wish to contact such as the Manic

Depression Fellowship and The Samaritans. It was also suggested that participants may wish to contact their general practitioner if they had any concerns relating to issues covered in the survey. At the outset all participants were given contact information for members of the research team and an external contact should they wish to ask questions or make a complaint about any aspects of the survey.

Online surveys also raise the possibility of data contamination due to the possibility of the same individual completing the survey more than once (Rhodes et al., 2003; Wright, 2005; Alessi & Martin, 2010). This is a particular risk for surveys which offer an incentive for taking part. In the survey study described presently (see Chapter 5), participants were offered the opportunity of taking part in a prize draw to win £100 in gift vouchers. Therefore some individuals may have completed the survey multiple times to improve their chances of winning. In an effort to overcome this issue, sociodemographic information given by the respondents was inspected to identify potential duplicate responses.

4.2.4 Actigraphy

A key advantage to using actigraphy to record sleep and activity, is enhanced ecological validity. Actiwatches are relatively non-invasive as participants are simply instructed to wear them as they would a wristwatch. Therefore data obtained via actigraphy is more likely to reflect natural sleep and activity patterns than those obtained from a laboratory-based PSG assessment. The ability of actiwatches to record over multiple days and nights, also makes this particular method highly appropriate for studying the stability of circadian rhythms.

Studies comparing actigraphy and PSG estimates of sleep parameters, indicate high levels of agreement (Jean-Louis, Kripke, Cole et al., 2001; Kushida, Chang, Gadkary et al., 2001; de Souza, Benedito-Silva, Pires et al., 2003; Kaplan, Talbot, Gruber & Harvey, 2012). As PSG is commonly regarded as the “gold standard” method of sleep measurement, this

evidence strengthens the credibility and reliability of actigraphy-driven data. However, actigraphy is limited in that periods of sleep and wakefulness are determined based on relative movement, taking into account the level of activity recorded before and after the current epoch. For this reason, actigraphy is not as accurate as PSG in differentiating between periods of waking rest and sleep (Sadeh, 2011), often underestimating sleep onset latency (Vallières & Morin, 2003; Tonetti, Pasquini, Fabbri et al., 2008). Therefore it is recommended that researchers employ subjective sleep diaries alongside actigraphy, to compare subjective reports of bed times and sleep times against those generated by the software (Sadeh, 2011). However if participants forget to provide this information during the study, or provide inaccurate information, this may adversely affect the validity of the results.

Actigraphy is also constrained by the battery life of the watches. It is important to ensure that actiwatches are fully charged before being given to participants, as low battery life can result in data loss (Edinger, Wohlgemuth, Krystal & Rice, 2005; Wootton, Koller, Lawton et al., 2012). This may present a problem for studies which have access to a limited number of devices for a large number of participants. Actigraphy is by no means inexpensive, requiring the purchasing of the actiwatch devices themselves, the software package needed to score and analyse the data, and any additional hardware required to download the data and charge the actiwatch batteries. Studies with limited budgets will therefore be restricted in the number of watches they can purchase, which may impact on the duration of the recruitment period and the size of the sample. Researchers must also consider the possibility that actiwatches may be lost or damaged during the study, requiring replacement or repair. In order to facilitate the collection of actigraphy data in a timely manner, a number of actiwatch devices were borrowed from a neighbouring institution for the purposes of the present research.

4.2.5 Experience Sampling Methodology (ESM)

ESM also offers high ecological validity as participants are assessed within the context of their day-to-day lives. It was therefore felt that ESM would be well-suited to the study of mood and appraisal in clinical and non-clinical populations, providing an insight into how these processes interact and also the significance of these processes, within everyday life.

ESM enables research teams to study phenomena as they occur, therefore increasing the accuracy of self-report in comparison to retrospective measures (Schwarz, 2007). Hurlburt (1997) suggests that, on the whole, human beings find “retrospectively characterizing” their thinking quite challenging. Studies comparing retrospective and concurrent measures of experience support this position (see Shiffman, Stone & Hufford, 2008 for a review). Furthermore, ESM enables researchers to obtain information which is very difficult, if not impossible, to obtain by more traditional means. For example, an individual may report experiencing abnormally high levels of negative affect for reasons that are not immediately apparent. Clinical interviewing may prove ineffective in uncovering the underlying reason for this change in mood. However, ESM would potentially illuminate particular triggers of negative affect, such as certain contexts or people, which he or she was not consciously aware of or did not feel comfortable disclosing to a health professional (Hurlburt & Sipprelle, 1978).

Conversely, the nature of ESM means that researchers are unlikely to uncover rare, but theoretically important events, as the information provided by participants is framed by the diary items (Hurlburt, 1997). Furthermore, research suggests that responses obtained from self-report measures are heavily influenced by the format and wording of the items (Schwarz, 1999). A further limitation of ESM, is that it does not offer researchers much in the way of experimental control. This may be particularly problematic for studies investigating causal relationships between phenomena. Whilst confounding variables are virtually impossible to control for in ESM studies, it is possible to record a number of potential confounds and address them within the analysis (i.e. controlling for the day of the week, persons present etc).

Conversely, a key motivation for using ESM in psychological research is to study phenomena in the context within which they naturally occur, therefore attempts to control for environmental influences may be counterintuitive.

ESM may also be criticised with regard to the burden placed on participants. In many studies, participants are instructed to keep the ESM diary with them at all times and are encouraged to respond to as many prompts as possible, typically ranging from five to ten prompts per day (Palmier-Claus, Myin-Germeys, Barkus et al., 2011). Some participants may find this irritating and intrusive, but may persevere with the study so as not to disappoint the researcher. Burden placed on participants is also likely to influence ratings of mood throughout the study, which is a major concern for studies concerned with momentary fluctuations in mood. In the present research, this issue was addressed by including an item at the end of each diary entry which asked participants to indicate how irritating they found the prompt. This information was then taken into account when analysing mood intensity.

4.2.5.1 Development of the ESM Diary

The ESM diary used in Study 2 is presented in Appendix 3. In the present research, participants completed ESM diaries for a period of 7 days alongside the assessment of circadian and social rhythm stability via actigraphy and completion of the daily SRM (Monk et al., 1990). This design allowed for examination of potential interactions between circadian and social rhythm instability, appraisal style and mood, and was therefore well-suited to answering the key research questions outlined below. Experts in the field also recommend that experience sampling of severe mental illness populations should take place over a period of at least 6 days to obtain an accurate representation of the phenomena of interest (Myin-Germeys & van Os, 2007; Palmier-Claus et al., 2011). Furthermore, a 7 day ESM period would enable exploration of any weekend effects in mood or appraisal style.

In deciding how often participants should be prompted throughout the course of each day, we endeavoured to strike a balance between limiting the burden placed on participants and obtaining a representative impression of experiences. The results of the pilot study, in addition to feedback from a bipolar service user research group, indicated that 10 alerts would be reasonable. This resembles the frequency of alerts employed by similar ESM studies (Myin-Germeys, Van Os, Schwartz et al., 2001; Myin-Germeys, Peeters, Havermans et al., 2003; Kimhy, Delespaul, Corcoran et al., 2006; Hartley, Haddock, Vasconcelos et al., 2013). The alerts were programmed based on semi-random time schedules which had been developed using a random number generator. This meant that the participant could not anticipate the timing of the next alert, and would therefore be less likely to consciously, or unconsciously, pre-plan their responses. The semi-random nature of the alerts also reduced the likelihood of “back-filling” where participants complete diary entries retrospectively (Ebner-Priemer & Trull, 2009a).

The structure and ordering of the diary items was carefully considered, ensuring that questions assessing transient mood experiences were asked first, followed by items assessing more stable phenomena such as appraisals of current experiences and contextual factors (Palmier-Claus et al., 2011). It is recommended that the average time taken to complete each diary entry should not exceed 3 minutes (Palmier-Claus et al., 2011). This criterion emphasizes the need to restrict the number of items included in the diary, highlighting the importance of applying careful and rigorous methods in the selection process which is described below.

4.2.5.1.1 Mood Items

To focus participants on the moment just before the beep, rather than the moment just after the beep, mood items were preceded by the following statement: “Please describe your mood just before the text alert went off”. All mood items were preceded by the phrase “I

feel...” to emphasize the momentary nature of the questions, and also to increase the perceived intimacy of the items as recommended by Delespaul (1995). The strength of each affect item was assessed on a 1 to 7 point Likert scale ranging from “Not” to “Very”.

Candidate diary items for the assessment of affective states were initially identified from a recent factor analysis, generating separate factors for positive and negative affect (Havermans, Nicolson, Berkhof & deVries, 2010). These items were then cross-referenced with items from the Hamilton Depression Rating Scale (HDRS; Hamilton, 1960; 1967), Bech-Rafaelsen Mania Scale (MAS; Bech, Bolwig, Kramp et al., 1979), Positive and Negative Affect Schedule (PANAS; Watson, Clark & Tellegen, 1988), and the activation and depression subscales of the Internal States Scale (ISS; Bauer, Crits-Christoph, Ball et al., 1991). A literature search was also performed to identify existing ESM studies which had assessed positive and negative affect. The items selected for piloting not only loaded heavily on the separate positive and negative affect factors reported by Havermans et al. (2010), but were also related to validated measures of affect, and had previously appeared in similar ESM investigations.

Nine mood items were included. The three positive affect items were “cheerful”, “energetic” and “confident”. The items included to assess negative affect were “bad about myself”, “down” and “guilty”. For the purposes of a separate study, a further three items were included to assess current anxiety. Participants’ scores on the three positive affect items at each entry were averaged to form a measure of average positive affect, whilst scores on the three negative affect items were averaged to form a measure of average negative affect.

4.2.5.1.2 Appraisal Items

Internal and external-normalising appraisal styles were measured using items selected from the Hypomania Interpretations Questionnaire (HIQ; Jones, Mansell & Waller; 2006a) and the Interpretations of Depression Questionnaire (IDQ; Jones & Day, 2008). It was

initially anticipated that the diary would include four appraisal items, reflecting the items which loaded most heavily on the HIQ-H, HIQ-N, IDQ-D and IDQ-N. Therefore a principal components analysis (PCA) was performed on all four subscales separately, based on data obtained by Jones and Day (2008). For items on the HIQ-H, the PCA generated three factors with eigenvalues greater than 1. These were “Positive beliefs about the self in relation to others”, “Positive beliefs about capability”, and “Positive beliefs in relation to positive self-attributes”. Three factors were also generated from the PCA of the HIQ-N. These were “Things are going smoothly at present”, “Awareness of a slight relapse”, and “Acknowledgement of external pressures”. For items on the IDQ-D, the PCA generated only one factor with an eigenvalue greater than 1. Similarly, for the IDQ-N, only one factor emerged from the PCA. Due to limited space in the diary, and concerns regarding participant burden, it was agreed that only one item from the HIQ and IDQ could be included in the ESM diary.

Therefore only items which loaded heavily on both the internal and external appraisal components, were considered for inclusion in the diary. This resulted in item 6 of the IDQ being selected as it loaded most heavily on the IDQ-N component, and was the 3rd most heavily loading item on the IDQ-D component. Inspection of the component matrices revealed that item 7 of the HIQ loaded most heavily on the “positive beliefs about the self in relation to others” component of the HIQ-H, and also on the “things are going smoothly at present” component of the HIQ-N. Therefore this item was selected for inclusion in the diary.

The suppositional structure of the original HIQ and IDQ items (e.g. “If I felt...I would probably think it was because...”), do not lend themselves to experience sampling investigations which are concerned with testing phenomena in the current moment. Therefore for the purposes of the current study, these items were adapted to reflect current appraisal styles (i.e. “Right now I am...I feel like this because...”).

4.2.5.1.3 Contextual Items

Requesting information regarding an individual's current mood may in itself influence the response given. For example, being asked to rate how guilty one currently feels is likely to trigger thoughts associated with guilt. In an effort to reduce this effect, Palmier-Claus and colleagues (2011) recommend the inclusion of contextual questions to deflect participants from solely focusing on their symptoms and mood. In the current study, participants were asked to indicate where they were and who they were with when completing each diary entry. Participants were also asked to indicate how threatened and how comfortable they felt in the company of those present on a 1 to 7 point Likert scale, as it was anticipated that these factors would impact on current mood ratings.

4.2.5.1.4 Other Items

As recommended by Delespaul (1995), at each entry participants were asked to state the most important or significant event that had happened to them since the previous alert, and then to indicate how pleasant this event was on a 1 to 7 point Likert scale. Assessment of experiences which have occurred between alerts has also been advocated by Palmier-Claus et al. (2011), in an attempt to capture important information which may not be detected by momentary items alone. For example, since the previous alert a participant may have received news that a close friend has been diagnosed with cancer.

At the briefing appointment, participants were instructed to respond to each alert as soon as possible, i.e. within 10 minutes of the alert if possible, due to the fact that the study was concerned with the participants' most immediate reactions and thoughts. In order to establish the time lapse between the alert being received and completion of each diary entry, participants were asked to state the time at which they completed each entry. This information was then used to distinguish between eligible and ineligible responses at the preparatory stage of analysis.

4.2.5.1.5 Daily Items

On the final page of each daily diary, participants were asked to complete a series of questions before going to bed. These questions included listing daily hassles that had disrupted their usual routine or activity. This question served as a check that the ESM responses given for that day, in addition to the actigraphy and SRM data, represented an average representation of the participant's mood, sleep, activity and routine.

Participants were also instructed to note down any times when they were not able to respond to the alert, and to provide a reason why (for example, periods when they were driving, sleeping, or busy at work). This would enable categorisation of any missing data and also indicate the feasibility of using ESM within each study population.

In the final section of the diary, participants were asked to rate how ordinary the day had been, how much they felt completing the diary had in itself influenced their mood, and lastly, how much they felt they would have behaved differently during the day without wearing the ESM watch. These items were originally developed by Delespaul (1995), and were used in the current study to assess the normalcy of each day and also to assess the degree of interference caused by the methodology as described above.

4.2.6 Piloting of Methodology

All methodologies were piloted within non-clinical and bipolar populations, and indicated adequate feasibility and acceptability within the two groups.

4.3 Statistical Approach: Moderation vs Mediation

In the current thesis, it was hypothesised that internal appraisal style would moderate the relationship between circadian and social rhythm instability and mood in bipolar disorder.

Mediation analysis is performed when wanting to explore whether or not a potential mediator variable (M) intercedes the relationship between an independent variable (X) and a dependent variable (Y ; Fairchild & MacKinnon, 2009). In other words, mediation effects represent how or why X is related to Y . According to Baron and Kenny (1986), a mediation effect requires that; a) X is related to M ; b) M is related to Y ; and c) X is related to Y (see Figure 1).

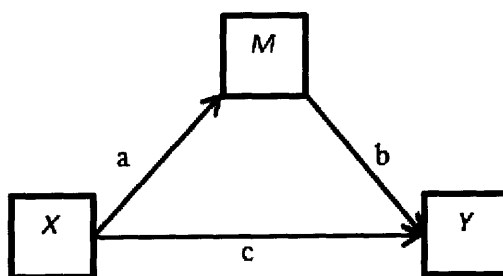


Figure 1. Mediator Model.

Conversely, moderator models indicate under which conditions X is related to Y , by examining the effect of a moderator variable (Z) upon the strength or direction of the relationship between X and Y . Moderation analysis requires that; i) X is related to Y ; ii) Z is related to Y , and; iii) the interaction between XZ is related to Y (Aiken & West, 1991; see Figure 2).

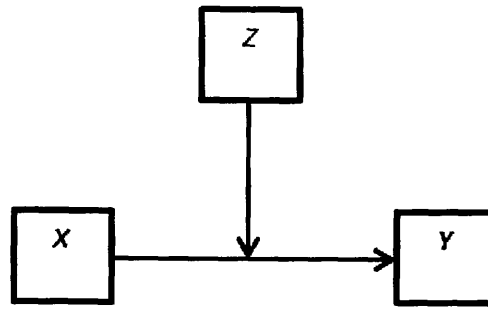


Figure 2. Moderator Model.

It is possible that appraisal styles both mediate and moderate the relationship between rhythm instability and mood in bipolar disorder, i.e. circadian/social rhythm disruption may impact on mood via internal appraisals, and an internal appraisal style may strengthen the relationship between circadian rhythm disruption and mood. However, mediation analysis assumes that; i) there is no interaction between the dependent and mediator variable, and; ii) the relationship between the dependent variable and the independent variable is not bi-directional (Fairchild & MacKinnon, 2009). Due to evidence demonstrating that circadian rhythm instability and internal appraisal styles coexist in behavioural high-risk populations (Ankers & Jones, 2009), in addition to evidence that mood states exacerbate sleep disturbance in bipolar disorder (Bauer, Grof, Rasgon et al., 2006; Talbot, Stone, Gruber et al., 2012), it was decided that mediation analysis would be inappropriate for the purpose of the current research. Therefore a moderation hypothesis was investigated, suggesting that the tendency to internally appraise experiences alters the strength of the effect of rhythm disruption upon mood rather than providing a mechanism by which such disruption causes mood change.

4.4 Objectives of the Current Research

The current research aimed to examine a multilevel cognitive model of bipolar disorder proposed by Jones (2001), based upon the ideas presented by Power and Dalgleish (1997). The relationship between circadian and social rhythm instability, appraisal style and mood was assessed across four populations with differing degrees of bipolar vulnerability. The principle aims of the research are outlined below.

4.4.1 Research Aim 1: Test the Relationship between Circadian and Social Rhythm Instability and Mood.

Hypothesis 1(A): The severity of mood states in the bipolar sample will be positively associated with the degree of circadian and social rhythm instability.

In Study 1, this hypothesis was tested by examining correlations between scores on measures of affective symptoms and scores on measures of sleep quality and social rhythm regularity in the bipolar sample. In Study 2, this hypothesis was tested by examining correlations between weekly average indices of circadian and social rhythm instability, and momentary levels of positive and negative affect.

Hypothesis 1(B): Non-clinical controls will demonstrate better circadian and social rhythm stability, and will exhibit less severe mood states, than individuals with a diagnosis of bipolar disorder, individuals with a diagnosis of fibromyalgia, or individuals deemed to be at behavioural high-risk for bipolar disorder.

In Study 1 this hypothesis was tested cross-sectionally by comparing scores on the measures of circadian and social rhythm instability and affective symptoms, between the four study groups. In Study 2, this hypothesis was tested cross-sectionally by comparing average

weekly scores on the various measures of circadian stability, in addition to average momentary ratings positive and negative affect over the week, between the study groups.

4.4.2 Research Aim 2: Test the Relationship between Internal Appraisal Style and Mood.

Following Jones' (2001) model, internal appraisals of experiences are associated with shifts toward bipolar-relevant mood states. Therefore, it was anticipated that positive, internal appraisals styles would correlate positively with positive, activated mood states, whilst negative, internal appraisal styles would positively correlate with negative, depressed states.

Hypothesis 2(A): The intensity of internal appraisal styles will positively correlate with the intensity of bipolar-relevant mood states in the bipolar sample.

This hypothesis was tested in Study 1 by examining correlations between scores on the two measures of internal appraisal style (i.e. positive internal and negative internal appraisal) and scores on the affective symptom measures in the bipolar sample. In Study 2, this hypothesis was tested cross-sectionally by examining momentary relationships between scores on the two internal appraisal items and levels of positive and negative affect.

Hypothesis 2(B): Individuals with a diagnosis of bipolar disorder will demonstrate a stronger tendency to form internal appraisals of experiences compared to the other study groups.

Due to the intense mood states associated with bipolar disorder, it was predicted that individuals with bipolar disorder would demonstrate a stronger tendency to adopt internal appraisals for experiences than individuals who do not experience such extremes in mood (i.e. non-clinical controls, high-risk individuals, and individuals with fibromyalgia). This was tested cross-sectionally in Study 1 by comparing average scores on the two measures of

internal appraisal style between groups. This was further explored in Study 2 by conducting multilevel group comparisons on scores relating to momentary internal appraisals over the study week.

Hypothesis 2(C): The relationship between circadian and social rhythm instability and mood in bipolar disorder will be weaker without the added influence of internal appraisal style.

This was considered the most important hypothesis with regard to validating Jones' (2001) suggestion that internal appraisals influence the effect of rhythm instability upon mood in bipolar disorder. In Study 1 and Study 2, this hypothesis was initially tested in the clinical bipolar sample only, with the intention of testing this relationship in the three comparison groups if significant moderating effects were observed. In Study 1, this hypothesis was investigated cross-sectionally by examining interactions between scores on the measures of sleep and social rhythm disturbance and appraisal style, to form a model which best explained reported mood states within the bipolar sample. In Study 2, this was investigated using multilevel regression models due to the nested structure of the ESM data.

4.4.3 Research Aim 3: Explore the Variability of Circadian Rhythms and Mood in Bipolar Disorder.

Bipolar disorder is associated with instability in a number of areas, including self-esteem, mood and sleep duration (Henry, Mitropoulou, New et al., 2001; Knowles, Tai, Jones et al., 2007, Millar, Espie & Scott, 2004). Therefore in Study 2, alongside examining the quantity of sleep disturbance in each population, the degree of sleep variability across days was also explored. The nature of the methodology employed in Study 2, also permitted exploration of the variability of negative and positive moods from moment to moment.

4.5 References

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Study 1:

**Associations between Circadian and Social Rhythm Instability, Appraisal
Style and Mood in individuals with and without Bipolar Disorder: Results
of a National Online Survey**

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5.1 Abstract

Background: Internal appraisal styles, in addition to circadian and social rhythm instability, have been implicated in the development of bipolar symptomatology, yet potential interactions between these variables remain unknown.

Aims: To examine relationships between rhythm instability, appraisal style and mood within populations at varying vulnerability for bipolar disorder.

Method: Individuals with bipolar disorder (n=51), individuals at behavioural high-risk for bipolar disorder (n=77), non-clinical controls (n=498), and individuals with fibromyalgia (a condition characterised by severe sleep disturbance; n=80) completed an online survey containing measures of sleep disturbance, social rhythm regularity, appraisal style and bipolar-relevant mood symptoms.

Results: Participants with bipolar disorder, and those at behavioural high-risk, exhibited poor sleep quality and a tendency to form internal appraisals of experiences. Bipolar participants exhibited a stronger tendency to adopt an internal, negative appraisal style compared to individuals at behavioural high-risk. However, the tendency to form internal, positive appraisals did not differ significantly between the two groups. In contrast to our hypothesis, internal appraisal styles did not moderate the relationship between rhythm instability and mood in bipolar disorder.

Conclusion: Sleep disturbance and internal appraisal styles are elevated in individuals with bipolar disorder, and demonstrate significant associations with low mood. Future research should employ a combination of self-report and objective methods to further assess the moderating effect of appraisal style upon rhythm instability. Potential differences in the effect of appraisal style at the state and trait level also warrant further exploration. An improved understanding of the relationships between these factors will have important clinical implications for individuals with bipolar disorder.

5.2 Introduction

Mood episodes which characterise bipolar disorder are associated with significant changes in both sleep and activity. During manic episodes, many individuals demonstrate increased motor activity along with a decreased need for sleep (American Psychiatric Association, 2000). During depressive episodes, individuals may experience both insomnia and hypersomnia, in addition to slowed psychomotor activity (American Psychiatric Association, 2000). Sleep and activity patterns are both examples of ‘circadian rhythms’ or 24-hour biological cycles (Kryger, Roth & Dement, 2011). Disturbances in circadian rhythms have been implicated across a number of psychiatric conditions including bipolar disorder, borderline personality disorder, obsessive-compulsive disorder, schizophrenia and major depressive disorder (Edgar & McClung, 2013; Fleischer, Schäfer, Coogan et al., 2012; Lange, Lange, Hauser et al., 2012; Murray & Harvey, 2010; Wulff, Dijk, Middleton et al., 2012).

Reports of low ‘social rhythm regularity’ in clinical populations (Shen, Alloy, Abramson & Sylvia, 2008; Sylvia, Alloy, Hafner et al., 2009; Boland, Bender, Alloy et al., 2012; St-Amand, Provencher, Bélanger & Morin, 2013) and populations at risk (Meyer & Maier, 2006; Bullock, Judd & Murray, 2011), also indicate that rhythm abnormalities may play an important role in the disorder. Social rhythms refer to regular activities which form daily patterns of behaviour, such as getting up, having breakfast and going to work (Monk, Flaherty, Frank et al., 1990). According to the social zeitgeber hypothesis (Ehlers, Frank & Kupfer, 1988), when social rhythms become disturbed this disrupts circadian rhythms leading to the onset of mood episodes in vulnerable individuals.

Whilst the association between circadian rhythm instability and mood episodes in bipolar disorder was first documented around thirty years ago (Wehr, Sack, Rosenthal et al., 1983; Wehr, Wirtz-Justice, Goodwin et al., 1979), recent research has indicated that disturbances in circadian rhythms are also present during periods of euthymia (Brill, Penagaluri, Roberts et al., 2011; Gershon, Thompson, Eidelman et al., 2012; Saunders,

Novick, Fernandez-Mendoza et al., 2013; Sylvia, Dupuy, Ostacher et al., 2012). Furthermore, a number of studies have reported predictive relationships between changes in sleep and activity and the subsequent onset of bipolar mood episodes (Jackson, Cavanagh & Scott, 2003; Murray, 2006; Proudfoot, Doran, Manicavasagar & Parker, 2011), suggesting that such changes significantly impact episode onset. Indeed, Goodwin and Jamison (1990) proposed that individuals at high-risk of developing bipolar disorder possess circadian rhythm ‘instability’, meaning that the stability of their sleep and activity patterns is vulnerable to disrupting events (i.e. events which disrupt daily routines and sleeping patterns such as long-haul flights). According to this hypothesis, the onset of mood episodes in clinical bipolar populations is triggered by circadian rhythm disruption.

It is important to note that disruptions in circadian and social rhythms are implicated in the maintenance, as well as the activation, of mood episodes in bipolar disorder (Harvey, 2008a). It is widely accepted that the relationship between circadian instability and mood change in bipolar disorder is bi-directional (Harvey, 2008b), with rhythm disruption triggering extreme shifts in mood, leading to behaviours which disrupt circadian and social rhythms further.

Although multiple lines of evidence point to the severity of circadian rhythm instability in bipolar disorder, the process by which circadian rhythm disturbance triggers mood change remains unclear. In 2001, Jones developed a multilevel cognitive model of bipolar disorder which integrated the instability model with principles outlined in the Schematic Propositional Analogical Associative Representation Systems (SPAARS) model of emotion (Power & Dalgleish, 1997). The SPAARS model presents a holistic approach to emotion, proposing that emotions are generated by information processed at multiple levels of cognition (see Appendix 2). It is suggested that emotions are initially generated by events which cause changes to the ‘analogical’ system (i.e. the senses), and that these changes are then interpreted at multiple, interacting levels of cognition resulting in a change in emotional state. In line with this model, Jones (2001) suggested that individuals vulnerable to bipolar

disorder exhibit an internal cognitive bias, leading them to attribute disruptions in circadian rhythms as personally relevant. It is argued that internal interpretations of the effects of rhythm disturbances trigger extreme mood states, leading to behaviours which cause further rhythm disruption, creating a vicious cycle (see Appendix 1).

In support of Jones' (2001) model, there is evidence that individuals with a diagnosis of bipolar disorder, in addition to non-clinical individuals at behavioural high-risk, exhibit a tendency to form internal appraisals of mood-relevant experiences (Alatiq, Crane, Williams & Goodwin, 2010; Ankers & Jones, 2009; Dodd, Mansell, Bentall & Tai, 2011; Mansell, Paszek, Seal et al., 2011). However, to date there have been no investigations of concurrent relationships between cognitive styles, rhythm disturbance, and mood in clinical bipolar populations, and only two studies have explored these factors in high-risk populations (Jones, Tai, Evershed et al., 2006; Ankers & Jones, 2009). Therefore further research in this area is clearly warranted, informing further understanding of the development and maintenance of bipolar experiences, and suggesting potential avenues for clinical intervention. It is also unclear whether or not a proposed relationship between rhythm disturbance and internal appraisal style is unique to bipolar disorder, or simply a contributing factor to chronic conditions in general. To address these issues, an online survey study was conducted involving individuals with bipolar disorder and three comparison groups; non-clinical controls, individuals at behavioural high-risk for bipolar disorder, and individuals with fibromyalgia.

Fibromyalgia is a musculoskeletal disorder, characterised by widespread chronic pain, cognitive deficits and severe sleep disturbance (Emad, Ragab, Zeinhom et al., 2008; Moldofsky, 2008). It was felt that a fibromyalgia sample would serve as an informative comparison group, on the grounds that such individuals exhibit similar circadian rhythm disruption to that documented in bipolar disorder (Korszun, 2000; Lineberger, Means & Edinger, 2007). With accumulating evidence of an association between fibromyalgia and a variety of mood disorders (Arnold, Hudson, Hess et al., 2004; Arnold, Hudson, Keck et al.,

2006; Fietta, Fietta & Manganelli, 2007), we were particularly interested in comparing this population with the bipolar sample to explore potential bipolar-specific processes in rhythms and appraisal style.

All participants completed a series of online self-report measures, which included measures of rhythm instability (i.e. sleep quality and social rhythm regularity), appraisal style and bipolar-relevant mood symptoms. It was hypothesized that non-clinical controls would demonstrate better sleep quality and social rhythm regularity compared to the other three populations (i.e. bipolar, fibromyalgia and high-risk), whilst the two clinical populations (i.e. bipolar and fibromyalgia) would demonstrate similarly elevated levels of rhythm instability (i.e. poor sleep quality and low social rhythm regularity). It was also hypothesised that bipolar participants would demonstrate higher symptom scores compared to the other three groups, in addition to a stronger tendency to form internal appraisals of hypomanic and depressive experiences. In line with Jones' (2001) application of the SPAARS model, it was also anticipated that internal appraisal style would serve as a moderator in the relationship between rhythm instability and mood, with internal appraisal styles strengthening this relationship.

5.3 Method

5.3.1 Participants

Individuals from four different populations took part in the present study; non-clinical controls, individuals at behavioural high-risk for bipolar disorder, individuals with bipolar disorder, and individuals with fibromyalgia.

Non-clinical controls and individuals at behavioural high-risk for bipolar disorder were identified based upon their scores on the Hypomanic Personality Scale (HPS; Eckblad & Chapman, 1986). In line with previous research, those scoring within the 10th decile of the distribution formed the behavioural high-risk group (Ankers & Jones, 2009; Meyer &

Hautzinger, 2003). A cut-off score of the sample mean plus one half of a standard deviation was used to identify non-clinical controls, such that anyone scoring below this cut-off formed the non-clinical control group. In the present study, non-clinical controls were classed as those who scored between 0 and 15 on the HPS, whilst high-risk participants were classed as those who scored between 22 and 48. Due to the inevitability that the mean HPS score would fluctuate with increasing participation, high-risk and control cut-off scores were calculated once at least 100 non-clinical participants had completed the HPS in full. Therefore the reported cut-off scores are based on data from 127 participants.

5.3.1.1 Inclusion Criteria

All participants were required to be 18 years of age or older to take part in the study. Fibromyalgia participants were required to report having a diagnosis of fibromyalgia given by a health professional, whilst bipolar participants were required to report having a diagnosis of bipolar disorder given by a mental health professional.

5.3.1.2 Exclusion Criteria

Participants were ineligible if they; i) were currently working night shifts, based on evidence demonstrating the disruptive impact of shift work upon circadian rhythms (Reinberg & Ashkenazi, 2008); ii) reported a comorbid diagnosis of bipolar disorder, or any other severe and enduring mental health problem, and fibromyalgia; iii) had ever received a diagnosis of dementia or physical brain injury, or; iv) reported experiencing a significant and prolonged sleep disturbance in the past month which was not related to a physical complaint or mental health problem, on the grounds that such individuals may be suffering from an undiagnosed sleep disorder.

Fibromyalgia and non-clinical participants were also ineligible if they had received a lifetime diagnosis of bipolar disorder, personality disorder or schizophrenia by a mental health professional. Bipolar and non-clinical participants were ineligible if they had a current diagnosis of a chronic pain disorder, given by a health professional.

<p><i>Personality</i></p> <p>1. Hypomanic Personality Scale</p> <p>2. Hypomanic Interpretations Questionnaire</p> <p>3. Interpretations of Depression Questionnaire</p> <p>4. Mood Disorders Questionnaire</p>
<p><i>Sleep and Activity</i></p> <p>5. Pittsburgh Sleep Quality Index</p> <p>6. Social Rhythm Metric (Trait)</p>
<p><i>Mood</i></p> <p>7. Hospital Anxiety and Depression Scale</p> <p>8. Internal States Scale</p>

Figure 1. Order in which survey measures were completed.

5.3.2 Procedure

Participants were recruited from a number of sources across the North West, Yorkshire and the East Midlands. Non-clinical individuals were mainly recruited from community settings and universities. Information about the survey was distributed to university staff via email, e-newsletters, and posters displayed around campus. The two clinical groups were largely recruited via online adverts on relevant websites, internet forums and social media sites. Additional bipolar participants were recruited from a participant research database, containing contact details of individuals with a diagnosed bipolar disorder who were interested in taking part in research.

All promotional materials directed potential participants to visit a link to the online survey homepage. After reading the study information, participants answered three consent questions followed by eleven screening questions to ensure that the inclusion criteria outlined above had been met. Participants then completed sixteen sociodemographic questions before proceeding to the main part of the survey which contained the core questionnaire measures (see section 5.3.4 for details). Figure 1. displays the order in which the questionnaire measures were completed. The survey was split into three areas; Personality, Sleep and Activity, and Mood.

On completion of these measures, participants were directed to a debriefing page which outlined the aims of the survey and listed contact details for members of the research team, in the event that participants had any queries about the research. Participants were also asked if they would like to receive feedback on their responses and receive a report of the results once the study had ended. All participants were given the opportunity to be entered into a prize draw to win £100 in Amazon vouchers. On the final page of the survey, participants were thanked for taking part and were given details for organisations to contact in the event that they had concerns about any of the topics covered in the survey (i.e. MDF, Samaritans, and the Fibromyalgia Association UK).

5.3.3 Data Screening

In order to identify duplicate responses which may have been entered by the same individual (e.g. in cases where technical problems had occurred and the participant started the survey again), reported date of birth was inspected to identify duplicate dates. Any data sets containing the same date of birth were then compared on other sociodemographic variables (i.e. gender, location, employment status, marital status, medication, treatment history). In the case of identical entries, only the most recent entry was retained.

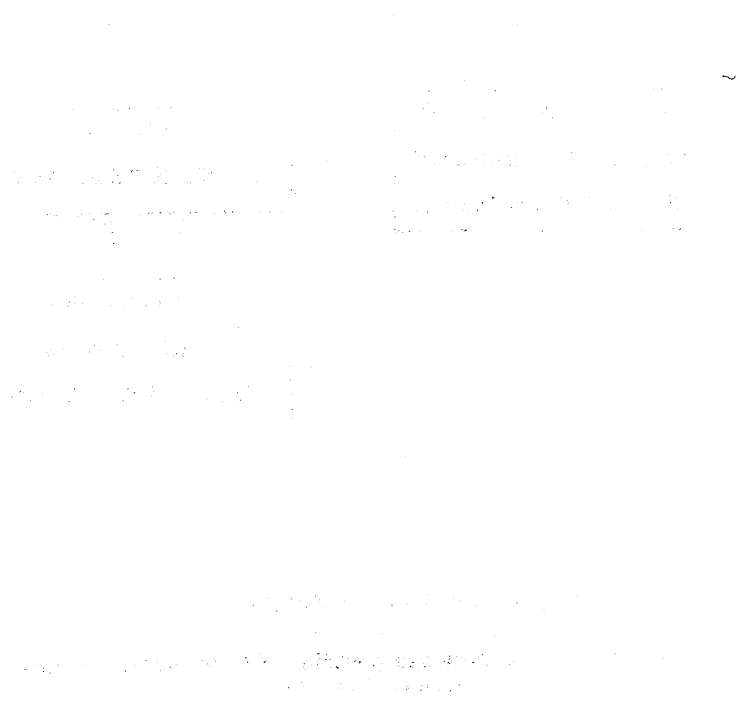
A number of participants did not complete any of the core study measures relating to rhythm instability, appraisal style, and mood, and were therefore excluded (see Figure 2.). In line with previous survey studies (Johnson & Carver, 2012; Johnson & Jones, 2009; Giovanelli, Hoerger, Johnson & Gruber, 2013), four ‘catch items’ were inserted throughout the survey (e.g. “Please select ‘True’”) to ensure that participants were answering the questions carefully and were not randomly selecting responses. Any data sets which contained at least one incorrect response to a catch item were excluded from the analyses.

All participants were required to complete the Mood Disorders Questionnaire (MDQ; Hirschfeld, Williams, Spitzer et al., 2000) to confirm the presence or absence of a self-reported bipolar diagnosis. Those who failed to complete the MDQ were excluded. Fibromyalgia and non-clinical control participants who scored positively on the MDQ were also excluded, as were bipolar participants who did not meet MDQ criteria. Due to reported rates of undiagnosed mood disorders in high-risk populations (Bentall, Myin-Germeys, Smith et al., 2011; MacKinnon, Zandi, Cooper et al., 2002; Wals, Hillegers, Reichart et al., 2001), and the fact that the MDQ has been found to demonstrate poor sensitivity in general population samples (Zimmerman & Galione, 2011), any high-risk participants who scored positively on the MDQ were not excluded.

In an attempt to control for the effects of clinically significant psychological disorders in the non-clinical and fibromyalgia groups, participants who reported suffering from any

mental health problem in the last 2 years were excluded from the analyses. In a similar vein, non-clinical participants who reported current use of anti-depressant or mood stabilising medication, were also excluded. One fibromyalgia participant was excluded due to reporting the use of hypnotic medication. Fibromyalgia participants who reported taking anti-depressants were not excluded due to concerns surrounding the representativeness of the sample, as anti-depressants are commonly prescribed to treat the physical effects of the disorder (Carville, Arendt-Nielsen, Bliddal et al., 2008; Häuser, Bernardy, Arnold et al., 2009; Perrot, Javier, Marty et al., 2008).

With the exception of fibromyalgia participants, any participants who reported a current diagnosis of a chronic pain disorder as diagnosed by a health professional were also excluded.



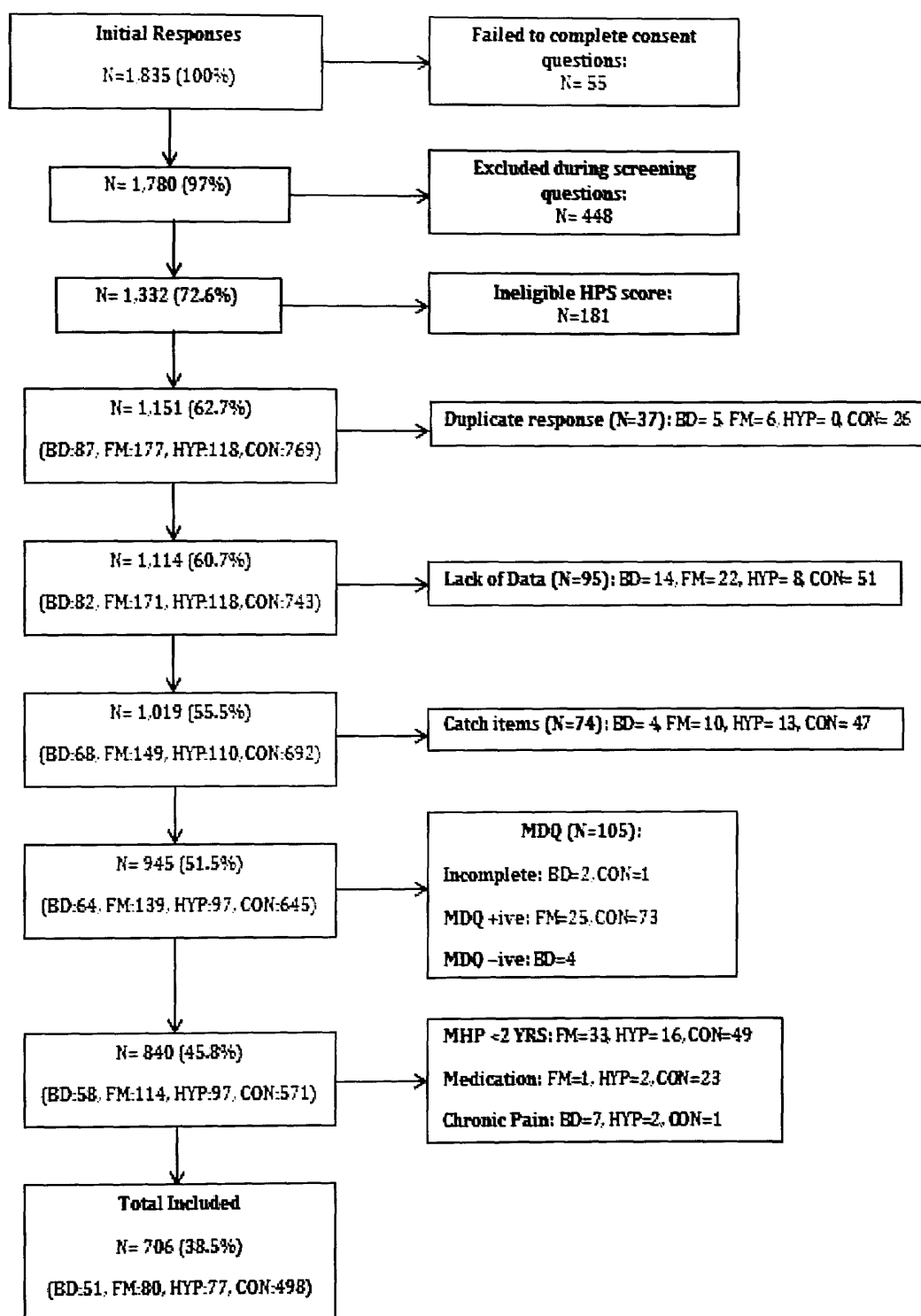


Figure 2. Data screening process.

Note: BD= Bipolar participants; FM= Fibromyalgia participants; CON= Non-clinical controls; HYP= High-risk participants; MHP= Mental health problem.

5.3.4 Measures

5.3.4.1 Measures of Bipolar Risk

Hypomanic Personality Scale (HPS; Eckblad & Chapman, 1986).

The HPS is composed of 48 true or false statements assessing hypomanic personality, which is defined as a gregarious and overactive disposition (Eckblad & Chapman, 1986). The HPS is a widely used screening tool for identifying individuals who present a behavioural risk for developing bipolar disorder. The scale includes items such as “Sometimes ideas and insights come to me so fast that I cannot express them all”, and “When with groups of people, I usually prefer to let someone else be the centre of attention”. The HPS offers good test-retest reliability ($r=0.81$) in addition to high internal consistency (Cronbach’s Alpha= 0.87; Eckblad & Chapman, 1986).

Mood Disorder Questionnaire (MDQ; Hirschfeld et al., 2000).

The MDQ was developed as a screening tool for detecting a likely mood disorder and has been found to have good internal consistency within UK samples (Cronbach’s Alpha= 0.91; Twiss, Jones & Anderson, 2008). The measure consists of 13 yes/no items relating to symptoms of mania, followed by two further questions which enquire as to whether the symptoms were experienced within the same time period, and if so, the impairment these symptoms caused for the individual. In order to improve the sensitivity of the MDQ for detecting the potential presence of bipolar spectrum disorders rather than just Bipolar I Disorder, Benazzi (2003) developed a less stringent scoring algorithm. This algorithm does not take into account the level of impairment experienced, as included in the original scoring criteria proposed by Hirschfeld et al. (2000). For the purposes of the present study, improvements in sensitivity were prioritised over specificity due to the focus on the bipolar sample over the other three comparison groups. Therefore the Benazzi (2003) scoring

algorithm was applied, such that participants had to report experiencing at least 7 of the 13 symptoms of mania within the same time period, to meet criteria for a likely mood disorder.

5.3.4.2 Measures of Circadian and Social Rhythm Instability

The Social Rhythm Metric- Trait (SRM-T; Shen et al., 2008).

The original Social Rhythm Metric (SRM; Monk et al., 1990) was designed to assess the stability of social rhythms, requiring participants to indicate which of 17 activities they had performed that day, and the time at which they had performed these activities, over a seven day period. The trait version of the SRM (i.e. the SRM-T) is comprised of the same 17 items, but is designed to assess social rhythm stability over the previous month. Participants indicate which activities they have performed regularly over the past month (i.e. activities which occur at approximately the same time each day, at least 3 times a week) and then indicate the frequency with which these activities were performed, ranging from 3 to 7 times per week. Two indices of social rhythm stability are generated; Regularity (REG) and Average Frequency (AVE). REG refers to the number of activities which were performed regularly each week (i.e. ranging from 0 to 17). AVE is then calculated by averaging the frequencies of each regular activity. The SRM-T has been found to demonstrate acceptable test-retest reliability in both bipolar and non-clinical control samples (i.e. $r = 0.62$; Grandin, Hafner, Gauger et al., 2006).

Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds III, Monk, Berman & Kupfer, 1989).

The PSQI consists of 24 items which aim to assess sleep quality over the past month. Of these 24 items, 5 are rated by the respondent's bed partner or roommate and do not contribute to the total score. Due to the nature of the present study, these 5 items were removed. The PSQI is divided into seven subscales (i.e. Sleep Quality, Sleep Latency, Sleep

Duration, Sleep Efficiency, Sleep Disturbance, Use of Sleep Medication, and Daytime Dysfunction), which together generate a global PSQI score ranging from 0 to 21. A global score above 5 indicates poor sleep quality (Buysse et al., 1989). The PSQI offers high internal reliability (Cronbach's Alpha= 0.83) and good test-retest reliability ($r = 0.85$; Buysse et al., 1989).

5.3.4.3 Measures of Appraisal Style

Hypomania Interpretations Questionnaire (HIQ; Jones, Mansell & Waller, 2006).

The HIQ was designed to assess appraisal styles for hypomania-relevant experiences. The questionnaire consists of 10 statements relating to signs and symptoms of hypomania, followed by an internal and an external appraisal of the experience (e.g. "If I felt impulsive, I would probably think it was because; a) I could make rapid decisions and good choices [internal appraisal], b) There are lots of external demands [external appraisal]"). Participants indicate the extent to which they agree with each appraisal on a 1 to 4 point Likert scale ranging from "not at all" to "a great deal", generating two separate subscales for internal and external-normalizing appraisal styles (i.e. the HIQ-H and HIQ-N respectively). Good levels of internal consistency have been reported for the HIQ-H ($\alpha = 0.72$ to 0.87) and HIQ-N ($\alpha = 0.70$), within clinical and non-clinical samples (Jones et al., 2006; Jones & Day, 2008).

Interpretations of Depression Questionnaire (IDQ; Jones & Day, 2008).

The IDQ was developed to assess appraisals for depression-relevant events. Adopting the same format as the HIQ, the IDQ consists of 10 statements relating to depressive experiences (e.g. "If I felt that nothing was working out for me I would probably think it was because...") followed by an internal appraisal (i.e. "...I struggle to get anything right in my life") and an external-normalizing appraisal (i.e. "...Too many obstacles are being put in my

way at present”). As described above, participants rate the degree to which they agree with each appraisal and also indicate whether or not they have experienced the situation in the last 3 months. Thus, the IDQ contains an internal appraisal subscale (IDQ-D) and external-normalising appraisal subscale (IDQ-N), similarly to the HIQ. The IDQ-D and IDQ-N have been shown to have excellent internal consistency (i.e. $\alpha = 0.90$ and 0.91 respectively) within the general population (Jones & Day, 2008).

5.3.4.4 Mood Outcome Measures

Internal States Scale (ISS; Bauer, Crits-Christoph, Ball et al., 1991).

This 15 item questionnaire is designed to assess bipolar-relevant mood symptoms. Each item relates to mood states over the last 24 hours, e.g. “Today I feel...”, requiring participants to rate how much they agree with each statement on a 100mm visual analogue scale. The 15 items contribute to 4 separate subscales; ISS-A (Activation), ISS-D (Depression), ISS-PC (Perceived Control) and ISS-WB (Well-Being). Higher scores on each subscale indicate worse outcome, apart from the ISS-WB. Bauer et al. (1991) have demonstrated the ability of the Activation and Well-Being subscales to discriminate between depression and mania in individuals with bipolar disorder. Additionally, the Activation and Depression subscales have been shown to correlate highly with clinician-rated measures of mania and depression (Bauer et al., 1991). According to Bauer, Vojta, Kinosian et al. (2000), scores on the ISS-A and ISS-WB subscales are able to discriminate between depressed (i.e. $\text{ISS-A} < 155$, $\text{ISS-WB} < 125$), mixed (i.e. $\text{ISS-A} \geq 155$, $\text{ISS-WB} < 125$), manic/hypomanic (i.e. $\text{ISS-A} \geq 155$, $\text{ISS-WB} \geq 125$), and euthymic (i.e. $\text{ISS-A} < 155$, $\text{ISS-WB} \geq 125$) mood states. Each of the four subscales offers good to excellent internal consistency, with alphas in the range of 0.81 to 0.92 for each scale (Bauer et al., 1991). As the ISS-PC represents a measure of global psychopathology, rather than relating directly to bipolar-relevant mood

states (Bauer et al., 1991; Bauer et al., 2000), only scores on the ISS-A, ISS-WB and ISS-D are presented.

Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith; 1983).

The HADS consists of 14 items assessing symptoms of anxiety and depression over the previous month. Participants read each statement (e.g. “Worrying thoughts go through my mind”) and then indicate the degree to which it applies to them on a four-point Likert scale, generating a score between 0 and 3 for each item. The HADS consist of separates subscales for anxiety (HADS-A) and depression (HADS-D), each with a maximum possible score of 21. According to Zigmond and Snaith (1994), a score between 0 and 7 indicates an absence of significant anxiety or depression. Scores between 8 and 10 are indicative of possible caseness for anxiety or depression, whilst scores between 11 and 15 indicate probable caseness, and scores of 16 or above indicate definite caseness for anxiety or depression. The HADS has been found to show good internal consistency within non-clinical samples (i.e. Cronbach’s Alpha= 0.86; Crawford, Henry, Crombie & Taylor, 2001).

5.3.5 Statistical Analyses

A power analysis was performed in ‘R’ (R Development Core Team, 2008) to ascertain the number of participants required in each group. Due to the lack of available data concerning scores on the HIQ and IDQ in bipolar and non-clinical control populations, in addition to the focus on rhythm stability in the present study, the power analysis was based upon AVE scores on the SRM-T between euthymic bipolar individuals and non-clinical controls. Assuming a significance level of .05 and power 0.8, a sample size of 57 per group would be necessary to detect a medium to large effect (i.e. Cohen’s $d = .72$).

Due to the non-normal distribution of scores on the ISS subscales and the internal appraisal/experience subscales of the IDQ and HIQ, non-parametric tests were performed to assess between-group differences and within-group correlations on these measures. As all other variables demonstrated a normal distribution, parametric tests were used for the majority of analyses. Due to the positive correlation between scores on the HADS-D and ISS-D across the sample ($r_s = .55, p < .0001$), depressive symptomatology was measured according to scores on the ISS-D only.

To control for the effects of multiple testing, a significance level of $p < .01$ was applied across all comparisons.

5.3.5.1 Between-Group Comparisons

Hypothesis 1- Non-clinical controls will demonstrate better rhythm stability (i.e. lower PSQI, higher REG and higher AVE scores) compared to individuals with a diagnosis of bipolar disorder, individuals with fibromyalgia, and individuals at behavioural high-risk for bipolar disorder.

Hypothesis 2- Participants with a diagnosis of bipolar disorder will demonstrate a stronger tendency to form internal appraisals of experiences (i.e. higher HIQ-H and IDQ-D scores) compared to the three comparison groups.

Hypothesis 3- Participants with a diagnosis of bipolar disorder will exhibit more severe mood states (i.e. lower ISS-WB and higher ISS-A, ISS-D and HADS-A scores) compared to the three comparison groups.

ANOVAs and Kruskal-Wallis tests were performed to test for differences in rhythm instability (see Hypothesis 1), appraisal style (see Hypothesis 2) and mood (see Hypothesis 3) between the four groups. Where significant effects were observed, post-hoc t-tests and Mann-Whitney tests were performed to examine where the differences lay.

5.3.5.2 Within-Group Comparisons

Hypothesis 4- Circadian and social rhythm instability (indicated by low REG and AVE scores, and high PSQI scores) will positively correlate with the intensity of extreme mood states (i.e. low ISS-WB and high ISS-A, ISS-D, and HADS-A scores) in the bipolar sample.

Hypothesis 5- Internal appraisal styles (indicated by high HIQ-H and IDQ-D scores) will positively correlate with the intensity of mood states in the bipolar sample.

Hypothesis 6- Internal appraisal styles will moderate the relationship between rhythm instability and mood in participants with bipolar disorder, meaning this relationship will be weaker without the added influence of internal appraisal style.

Relationships between rhythm instability and mood (see Hypothesis 4), and internal appraisal style and mood (see Hypothesis 5), in the bipolar sample were examined using Spearman's and Pearson's correlation coefficient. To test the moderating effect of internal appraisal style in the bipolar sample (see Hypothesis 6), a series of multiple regression analyses were performed for each of the four mood outcome variables. For each outcome variable, regressions were initially performed assessing the contribution of each predictor variable without any interaction terms. At the second step, interactions between internal appraisal style and rhythm instability were added to evaluate the degree to which internal appraisal style moderated the effects of rhythm instability upon mood. The regression coefficients produced by each interaction term are presented in Appendix 4.

Due to the degree of variation in the scale of the measures, all variables were standardized before the regression analyses were performed to facilitate clearer interpretation of the results. It was originally intended that a useful model would first be created in the bipolar sample, and then tested within the other three comparison groups. However, as none of the regression models within the bipolar group were significant at the $p < .01$ level, similar exploratory analyses within the three comparison groups was deemed to be inappropriate due to the focus on bipolar disorder in the current study.

5.3.5.3 Missing Data

Table 1 displays the percentage of participants within each sample who failed to complete each measure in full. The PSQI was the most poorly completed measure of the survey, followed by the SRM-T. It is possible that this is partly due to the cognitive effort required to complete these particular measures. For example, when completing the PSQI respondents are required to provide specific details about their sleep pattern, such as the average time they have gone to bed and how long it has taken them to fall asleep on average over the past month. Similarly to complete the SRM-T, respondents must remember how many times they have completed specific activities and the average time at which they completed such activities. The SRM-T is further complicated by the fact that respondents must also calculate whether or not an activity can be classed as occurring “regularly” (i.e. occurring within the same 45 time period each day at least 3 days per week). As the PSQI and SRM-T occurred within the second half of the survey, it is possible that participants were fatigued by this point, affecting their concentration and thus their ability to successfully complete these measures.

Due to the nature of these two measures (i.e. scores based on self-reported times and frequencies), in addition to the large sample size, it was decided that imputation would be inappropriate. Therefore, any incomplete responses to the PSQI (i.e. 11 bipolar, 18

fibromyalgia, 14 high-risk and 70 non-clinical control) or SRM-T (i.e. 2 bipolar, 6 fibromyalgia, 1 high-risk and 29 non-clinical control) were excluded from the analyses.

Thirty-five participants had between 1 and 8 items missing on the HIQ. Two non-clinical control data sets were excluded due to having more than 2 items missing. Where participants had missing data for 1 or 2 items (n=33), a value was imputed based on the mean of the completed responses within each sample. Participants with missing data on the IDQ, HADS or ISS, did not complete any of the measure. Therefore imputation was not viable, and these data sets were excluded from the analyses.

Table 1. Distribution of missing data as a proportion of each sample.

	BD (N= 51)	FM (N= 80)	HYP (N= 77)	CON (N= 498)
IDQ	2.0%	0.0%	0.0%	0.0%
HIQ*	9.8%	11.3%	13.0%	12.0%
PSQI	23.5%	40.0%	28.6%	26.7%
SRM-T	21.6%	25.0%	16.9%	21.1%
HADS	7.8%	21.3%	13.0%	16.7%
ISS	5.9%	21.3%	13.0%	14.9%

*Percentages include cases where mean imputation was applied (i.e. 25 control, 3 bipolar, 4 fibromyalgia and 1 high-risk).

5.4 Results

5.4.1 Sample Characteristics

The majority of responses to the survey were received from the general population (n=1,068) with 87 responses from individuals with bipolar disorder and 177 responses from

individuals with fibromyalgia. The responses given by the general population were composed of 769 non-clinical controls, 118 high-risk and 181 “ineligibles” (i.e. those who scored between 16 and 21 on the HPS). The process by which final sample sizes were obtained is outlined in Figure 2. In total, 51 bipolar, 498 non-clinical control, 80 fibromyalgia and 77 high-risk participants formed the final sample.

Sociodemographic information for each group is presented in Table 2. There was a significant difference in age between groups. Fibromyalgia participants were older on average, followed by bipolar participants, non-clinical controls, and high-risk participants. Post-hoc t-tests revealed that all groups significantly differed from one another in terms of age, apart from fibromyalgia and bipolar participants (see Appendix 5). As age did not significantly correlate with any of the study outcome measures, it was not controlled for in the main analysis.

Gender distribution differed significantly between groups ($\chi^2(3, N=706) = 15.39, p < .01$), with the highest proportion of females in the fibromyalgia group (i.e. 92.5%). Gender demonstrated a significant correlation with all outcome variables ($p < .001$), and was therefore entered as a covariate in the main analyses.

Medications were categorised according to their primary function (i.e. mood stabiliser, anti-depressant, anti-psychotic, hypnotic, and other/physical). For example, although amitriptyline is commonly prescribed to reduce pain severity, it is primarily used to treat symptoms of depression and was therefore classed as an anti-depressant in the present study. A significantly higher proportion of both bipolar and fibromyalgia participants reported taking medication for a physical health problem in comparison to the two non-clinical groups. In comparison to the bipolar participants, a significantly greater proportion of fibromyalgia participants reported taking anti-depressants. However this is likely related to the additional use of mood-stabilising medication in the bipolar sample (i.e. $n = 35.3\%$).

Significant group differences in marital status, employment and medication use were also observed. Employment status significantly correlated with scores on the PSQI, REG, IDQ-D, and ISS-WB, and was entered as a covariate for between-group comparisons on these measures. Marital status only demonstrated a significant association with scores on the PSQI, and therefore was only controlled for in between-group comparisons on this measure.

Table 2. Demographic information.

	BD (n=51)	FM (n=80)	HYP (n=77)	CON (n=498)	Group Difference
Age (SD)	42.06 (11.12)	44.82 (9.97)	30.03 (9.97)	36.46 (12.02)	$F(3, 702) = 25.266, p < .001$
Gender (%)					
Male	10 (19.6)	6 (7.5)	25 (32.5)	99 (19.9)	$\chi^2(3, N=706) = 15.39, p < .01$
Female	41 (80.4)	74 (92.5)	52 (67.5)	399 (80.1)	
Marital Status (%)					
Single	15 (29.4)	9 (11.3)	33 (42.8)	163 (32.7)	$\chi^2(9, N=706) = 38.03, p < .01$
Cohabiting	7 (13.7)	13 (16.3)	20 (26.0)	111 (22.3)	
Married/ Civil Partner	21 (41.2)	42 (52.5)	18 (23.4)	183 (36.7)	
Separated/ Divorced/ Widowed	8 (15.7)	16 (20.0)	6 (7.8)	41 (8.2)	
Employment Status (%) ^a					
Retired/ Unemployed	13 (25.5)	35 (43.8)	6 (7.8)	13 (2.6)	$\chi^2(9, N=706) = 182.63, p < .01$
Volunteer	10 (19.6)	0	0	5 (1.0)	
Student	2 (3.9)	6 (7.5)	21 (27.3)	97 (19.5)	
Part-Time	9 (17.6)	22 (27.5)	9 (11.7)	83 (16.7)	
Full-Time	17 (33.3)	17 (21.3)	41 (53.2)	300 (60.2)	
Medication					
Other/Physical	22 (43.1)	51 (63.7)	9 (11.7)	77 (15.5)	$\chi^2(3, N=706) = 109.76, p < .001$
Anti-Depressant	21 (41.2)	54 (67.5)	-	-	$\chi^2(1, N=131) = 7.78, p = .005$
Mood Stabiliser	18 (35.3)	-	-	-	
Anti-Psychotic	28 (54.9)	-	-	-	
Hypnotic	4 (7.8)	-	-	-	

^aFor the purposes of the chi-squared test, voluntary cases were removed due to the low frequencies.

5.4.2 Between-Group Comparisons

5.4.2.1 *Hypothesis 1- Non-clinical controls will demonstrate better rhythm stability (i.e. lower PSQI, higher REG and higher AVE scores) compared to individuals with a diagnosis of bipolar disorder, individuals with fibromyalgia, and individuals at behavioural high-risk for bipolar disorder.*

Table 3. displays the means, standard deviations and group differences for scores on the PSQI and the two indices of social rhythm regularity (i.e. REG and AVE). As predicted, the non-clinical controls scored significantly lower on the PSQI than the bipolar, fibromyalgia and high-risk participants, demonstrating better sleep quality than the other three groups. Differences in PSQI scores between the bipolar and high-risk participants failed to reach significance ($p=.03$) and also represented a small effect (see Appendix 5). Contrary to our hypothesis, there were no significant group differences in the number of regular activities performed over the previous month (i.e. REG), nor the frequency with which regular activities were performed over the previous month (i.e. AVE).

Table 3. Group means and standard deviations for measures of social rhythm regularity, sleep quality, appraisal style and mood.

	BD				FM				HYP				CON				Group Difference
	Mean (SD)	Median	IQR	n	Mean (SD)	Median	IQR	n	Mean (SD)	Median	IQR	n	Mean (SD)	Median	IQR	n	
REG	10.5 (3.5)			40	10.3 (3.5)			60	10.2 (3.4)			64	11.3 (2.9)			393	F(3, 548)=4.31, $p=.005$
AVE	5.5 (0.7)			40	5.7 (0.8)			60	5.5 (0.7)			64	5.6 (0.7)			391	F(3, 550)=0.73, $p=0.53$
PSQI	8.7 (3.8) ^a			39	13.3 (3.9) ^b			48	7.3 (3.8) ^a			55	5.3 (2.8) ^c			365	F(3, 495)=102.51, $p<.001$
HIQ-H	25.4 (8.5) ^a	24.0	13	49	14.8 (4.1) ^b	14	5	75	23.1 (5.5) ^a	23	6.25	68	17.1 (4.4) ^c	17	6	465	H(3)=131.48, $p<.001$
HIQ-N	23.7 (6.0)			49	21.8 (6.1)			75	23.5 (5.1)			68	22.7 (5.8)			465	F(3, 652)=1.53, $p=.20$
IDQ-D	23.6 (9.1) ^a	25	17.5	50	15.3 (5.7) ^b	14	6.5	80	15.8 (5.5) ^b	15	7	77	12.9 (3.9) ^c	12	4	498	H(3)=88.75, $p<.001$
IDQ-N	24.5 (5.9)			50	27.5 (6.3)			80	27.4 (6.2)			77	26.2 (6.7)			498	F(3, 700)=2.84, $p=.04$
ISS-A	122.9 (117.1) ^a	97.5	136.3	48	55.0 (64.8) ^b	30	95	63	164.3 (89.8) ^c	165	130	67	45.5 (50.4) ^b	30	75	424	H(3)=113.43, $p<.001$
ISS-WB	103.3 (88.0) ^a	80	122.5	48	82.0 (58.4) ^a	80	85	63	158.9 (68.2) ^b	161	100	67	146.0 (62.2) ^b	142.5	90	424	H(3)=65.70, $p<.001$
ISS-D	71.23 (64.5) ^a	60	105	48	56.3 (55.9) ^a	60	105	63	40.8 (46.4) ^a	20	80	67	24.9 (36.4) ^b	10	36.25	424	H(3)=49.13, $p<.001$
HADS-A	11.0 (4.5) ^a			47	8.7 (3.7) ^b			63	9.4 (4.4) ^{ab}			67	6.1 (3.6) ^c			415	F(3, 587)=38.37, $p<.001$

Post-hoc comparison: means with different subscripts differ significantly at $p<0.01$.

5.4.2.2 Hypothesis 2- Participants with a diagnosis of bipolar disorder will demonstrate a stronger tendency to form internal appraisals of experiences (i.e. higher HIQ-H and IDQ-D scores) compared to the three comparison groups.

The difference in HIQ-H scores between the groups was highly significant (see Table 3). Post-hoc comparisons indicated that bipolar participants scored significantly higher on the HIQ-H compared to non-clinical controls and fibromyalgia participants, indicating a stronger tendency to adopt an internal, positive appraisal style. However, the difference in HIQ-H scores between the bipolar and high-risk participants failed to reach statistical significance and also represented a small effect (see Appendix 5).

As predicted, bipolar participants scored significantly higher on the IDQ-D compared to all three comparison groups, indicating a stronger tendency to adopt an internal, negative appraisal style. However, the difference in IDQ-D score between the high-risk and fibromyalgia participants was not significant (see Appendix 5). No significant group differences were observed regarding scores on the normalising appraisal subscales of the HIQ and IDQ.

Although scores on both the HIQ-H and IDQ-D differed significantly between the non-clinical control and fibromyalgia participants, this represented a small effect in both cases (see Appendix 5).

5.4.2.3 Hypothesis 3- Participants with a diagnosis of bipolar disorder will exhibit more severe mood states (i.e. lower ISS-WB and higher ISS-A, ISS-D and HADS-A scores) compared to the three comparison groups.

Means, standard deviations and group comparisons for scores on the ISS and HADS subscales are also presented in Table 3. Contrary to our hypothesis, high-risk participants demonstrated the highest levels of activation, indicated by significantly higher ISS-A scores

compared to the other three groups. The difference in ISS-A scores between non-clinical controls and fibromyalgia participants was not statistically significant and represented a very small effect (see Appendix 5).

In terms of scores on the ISS-WB, only differences between the clinical and non-clinical groups were significant, with the non-clinical groups demonstrating higher levels of well-being on average (see Appendix 5). However, the difference in ISS-WB scores between non-clinical controls and bipolar participants represented a small effect ($r = .19$).

In contrast to hypothesised group differences in depressed mood, bipolar and high-risk participants' ISS-D scores did not significantly differ (see Appendix 5). Non-clinical controls exhibited the lowest scores on the ISS-D and differed significantly from the other three groups, although in all cases this represented a small effect (see Appendix 5). Fibromyalgia participants' scores on the ISS-D did not significantly differ from either the bipolar or high-risk groups.

Levels of anxiety, as indicated by scores on the HADS-A, were significantly higher in the bipolar sample compared to the fibromyalgia and non-clinical control groups, as predicted. However, high-risk participants' average HADS-A scores did not significantly differ from the bipolar or fibromyalgia participants (see Appendix 5).

Inspection of the mean ISS-A and ISS-WB subscale scores in line with classifications proposed by Bauer et al. (2000), suggested that only the non-clinical control group were euthymic at the time of completing the survey (see Table 3). ISS subscale scores in both the bipolar and fibromyalgia groups fell within the proposed threshold for depression, whereas the high-risk group exhibited scores indicative of a manic/hypomanic state.

5.4.3 Within-Group Comparisons

5.4.3.1 *Hypothesis 4- Circadian and social rhythm instability (indicated by low REG and AVE scores, and high PSQI scores) will positively correlate with the intensity of extreme mood states (i.e. low ISS-WB and high ISS-A, ISS-D, and HADS-A scores) in the bipolar sample.*

Correlations between bipolar participants’ scores on the mood symptom measures and scores on the measures of rhythm instability are presented in Table 4. The results partially supported the hypothesis, as only scores on the REG and PSQI demonstrated significant relationships with mood symptoms. As predicted, REG scores positively correlated with scores on the ISS-WB subscale, whilst scores on the PSQI were found to negatively correlate with ISS-WB scores (see Table 4). This suggests that better sleep quality, and performing a greater number of regular activities, were both associated with higher levels of well-being in the bipolar group.

Table 4. Correlations between scores on the mood symptom, internal appraisal style, sleep disturbance and social rhythm regularity measures in the bipolar group.

	REG (<i>n</i> =39)	AVE (<i>n</i> =39)	PSQI (<i>n</i> =38)	HIQ-H (<i>n</i> =47)	IDQ-D (<i>n</i> =47)
ISS-A	-.05	-.08	.07	.12	.25
ISS-WB	-.41*	.31	-.41*	.12	-.41*
ISS-D	-.13	-.32	.27	.11	.53**
HADS-A	-.36	-.31	.32	.14	.54**

Correlations in italics are Pearson’s *r*. All other correlations are Spearman’s.
p*<.01; *p*<.001

5.4.3.2 Hypothesis 5- Internal appraisal styles (indicated by high HIQ-H and IDQ-D scores) will positively correlate with the intensity of extreme mood states in the bipolar sample.

Contrary to the hypothesis, bipolar participants' scores on the HIQ-H did not significantly correlate with scores on any of the mood measures (see Table 4). However, scores on the IDQ-D positively correlated with scores on the HADS-A and ISS-D, and demonstrated a negative correlation with ISS-WB scores, as expected. Therefore the results suggest that tendencies to form internal, negative appraisals of experiences were associated with higher levels of depression and anxiety, and lower levels of well-being in the bipolar sample.

Table 5. Regression analyses for activation (ISS-A), well-being (ISS-WB), depression (ISS-D), and anxiety (HADS-A) in the bipolar group.

	β	CI	<i>p</i>
<u>ISS-A</u>			
Predictor			
Model 1(a)			
REG*HIQ-H	0.49	0.22 to 0.77	.001
Model 1(b)			
AVE*HIQ-H	0.18	-0.14 to 0.50	.27
Model 1(c)			
PSQI*HIQ-H	-0.40	-0.74 to -0.06	.02
Model 2(a)			
REG>IDQ-D	0.10	-0.23 to 0.43	.55
Model 2(b)			
AVE>IDQ-D	0.13	-0.23 to 0.47	.48
Model 2(c)			
PSQI>IDQ-D	-0.13	-0.51 to 0.25	.49
<u>ISS-WB</u>			
Predictor			
Model 3(a)			
REG*HIQ-H	0.25	-0.04 to 0.54	.09

Table 5. *(continued)*

	β	CI	p
Model 3(b)			
AVE*HIQ-H	0.18	-0.10 to 0.47	.20
Model 3(c)			
PSQI*HIQ-H	-0.12	-0.47 to 0.23	.50
Model 4(a)			
REG*IDQ-D	0.21	-0.08 to 0.51	.15
Model 4(b)			
AVE*IDQ-D	-0.07	-0.39 to 0.24	.65
Model 4(c)			
PSQI*IDQ-D	-0.05	-0.41 to 0.31	.77
 <u>ISS-D</u>			
 Predictor			
Model 5(a)			
REG*HIQ-H	-2.83	-0.62 to 0.05	.09
Model 5(b)			
AVE*HIQ-H	-0.07	-0.41 to 0.28	.69
Model 5(c)			
PSQI*HIQ-H	0.10	-0.27 to 0.47	.59

Table 5. *(continued)*

	β	CI	p
Model 6(a)			
REG*IDQ-D	-0.29	-0.63 to 0.04	.09
Model 6(b)			
AVE*IDQ-D	0.12	-0.24 to 0.478	.50
Model 6(c)			
PSQI*IDQ-D	0.30	-0.06 to 0.67	.10
 <u>HADS-A</u>			
Predictor			
Model 7(a)			
REG*HIQ-H	0.20	-0.12 to 0.52	.21
Model 7(b)			
AVE*HIQ-H	0.14	-0.20 to 0.49	.40
Model 7(c)			
PSQI*HIQ-H	-0.19	-0.57 to 0.20	.33
Model 8(a)			
REG*IDQ-D	-0.34	-0.66 to -0.03	.03
Model 8(b)			
AVE*IDQ-D	0.10	-0.27 to 0.46	.59
Model 8(c)			
PSQI*IDQ-D	0.35	-0.01 to 0.72	.06

Note: ISS-A= Activation subscale of Internal States Scale; ISS-WB= Well-being subscale of Internal States Scale; ISS-D= Depression subscale of Internal States Scale; HADS-A= Anxiety scale of Hamilton Anxiety and Depression Scale; HIQ-H= Internal appraisal subscale of Hypomanic Interpretations Questionnaire; IDQ-D= Internal appraisal subscale of Interpretations of Depression Questionnaire; REG= Number of regular activities performed over the past month; AVE= Average frequency with which regular activities were performed over the past month; PSQI= Pittsburgh Sleep Quality Index score.

For models including AVE or REG, $n = 39$. For models including PSQI, $n = 38$.

5.4.3.3 *Hypothesis 6- Internal appraisal styles will moderate the relationship between rhythm instability and mood in participants with bipolar disorder, meaning the relationship will be weaker without the added influence of internal appraisal style.*

Table 5. displays the interaction term regression coefficients for each mood variable in the bipolar group. The output for the contribution of all five predictor variables (i.e. PSQI, REG, AVE, HIQ-H, IDQ-D) to each outcome variable (i.e. ISS-A, ISS-WB, ISS-D, HADS-A) is presented in Appendix 4.

None of the regression equations regarding scores on the ISS-WB, ISS-D or HADS-A were statistically significant. Regarding scores on the ISS-A, only the interaction between HIQ-H and REG was statistically significant at the $p < .01$ level (see Table 5.). The beta coefficients indicated that for every one unit increase in the standard deviation of the interaction term, scores on the ISS-A increased by 0.49 points, which is greater than the separate effects of REG (i.e. $\beta = .04$) and HIQ-H (i.e. $\beta = .14$). The interaction between PSQI and HIQ-H scores demonstrated a similar effect upon ISS-A, although this was not significant at the $p < .01$ level ($\beta = -.40, p = .02$). In summary, the results did not support the hypothesised moderation effect of internal appraisal style.

5.5 Discussion

5.5.1 Summary of the Findings

Although appraisal style and rhythm instability have been implicated throughout the course of bipolar disorder, to date no study has assessed how these variables interact within a clinical bipolar sample. It is also unclear whether appraisal styles and disturbances in circadian and social rhythms are uniquely related to bipolar disorder, rather than being diagnostic of chronic conditions in general.

In support of our first hypothesis, non-clinical controls exhibited significantly better sleep quality than the other three groups, corroborating existing evidence of poorer subjective sleep quality in euthymic individuals with bipolar disorder (Harvey, Schmidt, Scarnà et al., 2005; Millar, Espie, & Scott, 2004; Ritter, Marx, Lewtschenko et al., 2012; Talbot, Stone, Gruber et al., 2012), individuals at behavioural high-risk for bipolar disorder (Ritter et al., 2012), and individuals with fibromyalgia (Osorio, Gallinaro, Lorenzi-Filho & Lage, 2006; Theadom & Cropley, 2008). It is noteworthy that the average PSQI score in the non-clinical control group is slightly above the poor sleeper cut-off score of 5 proposed by Buysse and colleagues (1989). It is possible that some participants were experiencing problems with their sleep, and therefore took part in the study to receive feedback on their sleep quality. However, the PSQI was originally developed using a US sample (Buysse et al., 1989), and subsequent studies with UK control samples have reported similar means to the current investigation (Wood, Joseph, Lloyd & Atkins, 2009). This suggests that the PSQI may not be sensitive to cultural differences in subjective sleep quality, and therefore the slightly higher mean observed in the current study may not necessarily indicate poorer sleep quality.

Findings regarding social rhythm regularity indicated a lack of significant differences between the groups. The slightly under-powered bipolar sample may partly account for the non-significant findings, particularly as the data demonstrated a trend in the expected direction. Although the three comparison groups were adequately powered to detect medium to large effect size differences in average frequency, the mean scores reported for all four groups were almost identical, suggesting that the average frequency with which regular activities are performed does not play a significant role in bipolar disorder.

As anticipated, bipolar participants demonstrated higher scores on the HIQ-H compared to the non-clinical controls and fibromyalgia participants, indicating a stronger tendency to internalise hypomanic experiences. However, individuals at behavioural high-risk for bipolar disorder also demonstrated this tendency, suggesting that hypomanic appraisal styles may represent a bipolar vulnerability. As the difference in HIQ-H scores between

fibromyalgia participants and the two bipolar-vulnerable groups represented particularly large effects, this indicates that hypomanic appraisal styles may be important in differentiating individuals vulnerable to bipolar disorder in comparison to individuals vulnerable to a similarly chronic condition.

Conversely, the tendency to form internal appraisals of depressive experiences was much greater in the bipolar group compared to both the fibromyalgia and high-risk groups. This emphasizes the role of negative cognitions in bipolar disorder, corroborating findings reported by Kelly, Mansell, Wood et al. (2011). However, inspection of the average ISS scores in line with classifications proposed by Bauer et al. (2000), indicates that the bipolar participants were borderline depressed when completing the survey. Therefore, negative, internal appraisal styles may have been more strongly activated in the bipolar group due to higher levels of negative affect as suggested by Teasdale's Differential Activation Hypothesis (1983, 1988). It is possible that internal appraisal styles represent state-modulated trait variables in bipolar disorder, i.e. are present throughout all phases of the disorder but become more extreme in response to mood change (Clark & Goodwin, 2004).

The groups did not differ significantly with regard to scores on the external-normalising subscales of the HIQ and IDQ, corroborating results reported by similar studies (Jones & Day, 2008; Ankers & Jones, 2009; Johnson & Jones, 2009; Dempsey, Gooding & Jones, 2011; Dodd et al., 2011). The results indicate that euthymic bipolar individuals, individuals with fibromyalgia, and non-clinical individuals at behavioural high-risk, are able to access normalising appraisals of experiences similarly to non-clinical controls. The findings therefore suggest that external appraisal styles are not strongly implicated in bipolar disorder.

In the present study we observed similar levels of sleep disturbance in euthymic individuals with bipolar disorder compared to individuals at behavioural high-risk, corroborating earlier findings reported by Ritter et al. (2012). The two groups also demonstrated similarity regarding the tendency to form positive, internal appraisals of events.

As the high-risk individuals demonstrated similar scores to the bipolar participants and yet differed significantly from the non-clinical controls, these findings suggest that a tendency to form internal, positive appraisals of experiences, in addition to severe sleep disturbance, may represent vulnerability factors in bipolar disorder. Whilst these findings require replication, they offer support to models which emphasize the importance of sleep disturbance and internal appraisal style in the course of bipolar disorder (Jones, 2001).

We found partial support for our second hypothesis that bipolar participants would demonstrate more intense mood states compared to the three comparison groups. Although the bipolar participants exhibited significantly higher levels of activation compared to the fibromyalgia and non-clinical control participants, individuals at behavioural high-risk for bipolar disorder demonstrated the highest level of activation of all four groups, meeting criteria for mania/hypomania according to their scores on the ISS-A and ISS-WB. This is surprising given that the high-risk group was recruited from a non-clinical population who supposedly do not experience clinical symptoms of mania. However, it is possible that the results reflect greater mood instability in the high-risk group compared to the other three populations. This is supported by the results of Hofmann and Meyer (2006), who reported a positive correlation between scores on the HPS and instability of affective symptoms. Furthermore, the relatively lower levels of activation in the bipolar group may reflect treatment effects, as mood-stabilising medication, in addition to receipt of psychological interventions, have been shown to reduce symptoms of mania in bipolar populations (Gitlin & Frye, 2012).

Contrary to our hypothesis, bipolar participants did not significantly differ from individuals with fibromyalgia in terms of current depression. Both groups also demonstrated similarly low levels of subjective well-being relative to non-clinical participants. When viewed together, the results indicate higher levels of depression in chronic conditions compared to non-clinical populations, corroborating existing evidence (Barghouti, Yasein & Bani Mustafa, 2013; Rothrock, Hays, Spritzer et al., 2010). A significant effect of chronicity

regarding rhythm instability, and tendencies to adopt internal appraisal styles, was not observed. Individuals with fibromyalgia demonstrated significantly worse sleep disturbance than euthymic bipolar individuals, and were significantly less likely to internally appraise events. The current findings suggest that euthymic bipolar individuals demonstrate better subjective sleep quality than individuals with similarly chronic conditions. However, very few studies have been carried out in this area, and those that have have tended to focus on comparisons between bipolar disorder and insomnia producing mixed results (Harvey et al., 2005; St-Amand et al., 2013; Talbot et al., 2012). Clearly further research comparing subjective sleep disturbance across different chronic populations will be necessary to determine whether or not such subjective disturbances are particularly relevant to bipolar disorder.

The findings of the current investigation, viewed alongside evidence of stronger internal appraisal styles in euthymic bipolar populations compared to euthymic unipolar populations (Alatiq et al., 2010; Kelly et al., 2011; Mansell et al., 2011), suggest that internal appraisal styles may be representative of cognitions which play a unique role in bipolar disorder, rather than chronic conditions in general. However much more research is needed in this area to validate this claim.

On the whole, relationships between rhythm instability and mood symptoms in the bipolar group were not significant. Although subjective well-being demonstrated significant correlations with sleep disturbance and social rhythm regularity, none of the other symptom measures demonstrated a similar relationship. This is surprising given existing evidence of significant relationships between subjective sleep duration and symptoms of mania and depression in euthymic bipolar samples (Gruber, Miklowitz, Harvey et al., 2011; Kaplan, Gruber, Eidelman et al., 2011). However, studies reporting significant relationships between subjective sleep duration and mood in euthymic bipolar individuals, have tended to assess sleep at the state level using daily sleep diaries. Therefore the difference in findings may

indicate significant relationships between mood symptoms and subjective sleep at the state but not trait level.

In the present study, positive, internal appraisal styles were not significantly associated with mood symptoms in bipolar disorder, corroborating findings reported by Dodd et al. (2011). However, negative internal appraisal styles were found to correlate positively with levels of depression and anxiety, whilst demonstrating a negative association with well-being. These findings add support to multilevel approaches which emphasize the role of internal appraisal in bipolar mood change (Jones, 2001; Mansell, Morrison, Reid et al., 2007). However, this is the first study to assess negative, internal appraisal styles in a clinical bipolar sample using the IDQ. Furthermore, the study was only powered to detect between-group differences in AVE scores on the SRM-T, and therefore may have lacked sufficient power to detect within-group correlations between positive, internal appraisals and mood symptoms. In sum, replication of the findings will be required before firm conclusions may be drawn.

The main aim of the present investigation was to explore the moderating role of internal appraisal style in the relationship between circadian and social rhythm instability and mood. Overall, the results of the regression analyses indicated that internal appraisal styles did not significantly influence this relationship, suggesting that other important factors not included in the current study may be involved. However, the size of the bipolar sample in light of the power calculation, suggests that the regression analyses may have lacked statistical power. Consequently, the probability of Type II error is heightened. Additionally, applying a significance level of $p < .01$ may not have been low enough to reduce the risk of Type I error when one considers the number of comparisons made. The likelihood of these errors is perhaps reflected by the non-significant and inconsistent direction of the interaction effects.

5.5.2 Limitations

Before drawing conclusions from the study, there are a number of important limitations which must be acknowledged. Firstly, the current study employed a cross-sectional design, therefore it was not possible to examine causal relationships between rhythm instability, internal appraisal style and mood. Future investigations should seek to examine predictive relationships between these variables across multiple time points to explore the direction of potential relationships, in addition to levels of mood instability in populations at varying vulnerability for bipolar disorder. Secondly, only explicit appraisal styles were assessed. Existing research suggests a potentially important distinction between implicit and explicit cognitive styles (see Chapter 3), which may partly underlie the absence of a significant moderation effect in the present study. Therefore further research is needed to explore the impact of implicit appraisals upon the relationship between circadian and social rhythm instability, and mood.

Thirdly, all assessments were based on self-report. Although the measures employed have been validated in clinical populations, research suggests that assessments of sleep disturbance based on self-report versus objective methods can differ greatly (Buysse, Hall, Strollo et al., 2008). This highlights the need for future studies to employ both subjective and objective measures of sleep disturbance.

Fourthly, although non-clinical controls and individuals with fibromyalgia were excluded if they reported a recent diagnosis of a mental health problem or scored positively on the MDQ, it was not possible to confirm the clinical status of these participants using validated clinical interviews. Similarly we were unable to confirm self-reported diagnoses of bipolar disorder and fibromyalgia, which reduces the validity of the findings. The clinical status of the high-risk sample also presents a concern, with the majority scoring positively on the MDQ ($n = 54$). Therefore it is possible that a number of the high-risk participants were

experiencing clinically significant symptoms of bipolar disorder, which may limit the generalizability of the findings to the wider high-risk population.

5.5.3 Conclusion

In conclusion, the current study indicates that both negative and positive internal appraisal styles play an important role in bipolar disorder, although negative internal appraisals appear to be particularly important in differentiating clinical individuals from non-clinical individuals at behavioural high-risk. The findings of the current study suggest that poor sleep quality, but not social rhythm regularity, is particularly elevated in individuals with bipolar disorder and those at behavioural high-risk. Although well-being was associated with increased sleep disturbance and decreases in the number of regular activities performed in bipolar disorder, internal appraisal styles did not moderate this relationship. Future research should employ objective and subjective assessments of rhythm instability to explore the moderating effect of implicit appraisal styles in the relationship between circadian and social rhythm instability, and mood in bipolar disorder.

5.6 References

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Study 2:

**Assessment of the Relationships between Circadian and Social Rhythm
Instability, Internal Appraisal Style, and Mood in Bipolar Disorder using
Actigraphy and Experience Sampling**

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pp. 227-285

6.1 Abstract

Objectives: Whilst disturbances in circadian and social rhythms have been found to precede and exacerbate mood episodes in bipolar disorder, the processes which underlie this relationship are unknown. Multilevel cognitive models of bipolar disorder suggest that internal appraisal styles may moderate this relationship, however this is yet to be tested within a clinical population. The degree to which potential interactions between rhythm instability, appraisal style, and mood, represent processes specific to bipolar disorder, also requires investigation.

Methods: The present study employed a mixed design combining objective and self-report measures of rhythm instability, with momentary assessments of appraisal style and mood using experience sampling methodology (ESM). Forty-six euthymic bipolar individuals, fifty non-clinical controls, and thirty-eight individuals with fibromyalgia, were assessed with wrist-actigraphy and ESM for a period of 7 consecutive days and nights.

Results: Bipolar and fibromyalgia participants demonstrated similarly poor levels of sleep efficiency and sleep quality in comparison to non-clinical controls. Bipolar participants exhibited a tendency to adopt negative, internal appraisals of experiences, and also demonstrated higher and more variable levels of negative affect, in comparison to fibromyalgia and non-clinical control participants. However, the relationship between rhythm instability and mood was not statistically significant, and internal appraisal styles did not demonstrate a moderating effect.

Conclusions: The results indicate that internal appraisal styles are strongly associated with the intensity and variability of affect day-to-day in euthymic bipolar individuals. However, rhythm instability was not significantly related to momentary mood states in everyday life.

6.2 Introduction

The presence of instability in bipolar disorder is particularly notable within circadian and social rhythms (Jones, Hare & Evershed, 2005; Murray & Harvey, 2010; Shen, Alloy, Abramson & Sylvia, 2008). The term ‘circadian’ originates from the Latin for ‘circa’ meaning approximately, and ‘diem’ meaning day, thus circadian rhythms refer to biological processes which follow a roughly 24-hour cycle (Holtz Viaterna, Takahashi & Turek, 2001). Numerous examples of circadian rhythm instability in bipolar disorder can be found in the literature, particularly regarding the sleep-wake cycle (Harvey, Schmidt, Scarnà et al., 2005; Mehl, O’Brien, Jones et al., 2006; Plante & Winkelman, 2008). Sleep disturbances have not only been shown to precede mood episodes in clinical populations (Colombo, Benedetti, Barbini et al., 1999; Murray, 2006) and persist in the absence of clinically significant symptoms (Brill, Penagaluri, Roberts et al., 2011; Sylvia, Dupuy, Ostacher et al., 2012), but have also been identified in non-clinical individuals at behavioural high-risk for bipolar disorder (Ankers & Jones, 2009; Meyer & Maier, 2006).

Social rhythms are daily schedules or patterns of behaviour, which serve to entrain circadian rhythms (Monk, Flaherty, Frank et al., 1990). For example, having a job which requires 9am to 5pm working hours will impact the time at which someone goes to bed and gets out of bed, thus entraining the sleep-wake cycle. Individuals who perform a number of activities regularly each day are said to possess high social rhythm regularity (Monk et al., 1990). In comparison to non-clinical controls, individuals with bipolar disorder tend to report lower social rhythm regularity in addition to a higher incidence of events associated with social rhythm disruption (Sylvia, Alloy, Hafner et al., 2009; Boland, Bender, Alloy et al., 2012; St-Amand, Provencher, Bélanger & Morin, 2013). Individuals at behavioural high-risk for bipolar disorder have also been found to exhibit poor social rhythm regularity, indicating that the instability of daily routines is present before diagnosis rather than being purely consequential of the condition (Meyer & Maier, 2006; Bullock, Judd & Murray, 2011).

Whilst disturbances in circadian and social rhythms have been reported across various phases of the disorder, it is unclear whether these disturbances are uniquely associated with bipolar mood change, or are transdiagnostic of chronic conditions in general (Harvey, 2009). Answering this question would hold important clinical implications for how psychological treatment is delivered, not only for individuals with bipolar disorder, but also for individuals who present with similarly chronic conditions.

Although various psychological treatment approaches addressing the importance of sleep and routine in bipolar disorder have been shown to produce positive effects in reducing symptom severity and preventing relapse, many individuals who receive such interventions continue to experience significant problems in both clinical and social functioning (Frank, Kupfer, Thase, et al., 2005; Lam, Hayward, Watkins et al., 2005; Miklowitz, Otto, Frank et al., 2007). This point is corollary to the current lack of understanding regarding how rhythm instability impacts on mood in bipolar disorder. Multilevel cognitive models of bipolar disorder propose that disruptions in circadian and social rhythms impact on mood via cognitive processes, emphasizing the role of internal appraisal styles (Jones, 2001; Mansell, Morrison, Reid et al., 2007). It is suggested that individuals vulnerable to developing bipolar disorder possess a tendency to form internal appraisals of the physiological and cognitive consequences of circadian and social rhythm disruption (see Appendix 1). Internal appraisals reflect interpretations of experiences where one's own characteristics are seen as instrumental, e.g. "I passed my driving test because I am a good driver", as opposed to external appraisals which are focused on situational factors, e.g. "I passed my driving test because the roads were not busy". In bipolar disorder, disruptions to sleeping patterns may cause fatigue and a reduction in physical activity which, when interpreted internally, may lead to negative self-appraisals such as "I feel tired because I am useless". It is proposed that these internal appraisals then exacerbate mood states in bipolar disorder, leading to prodromal behaviours (Jones, 2001; Mansell et al., 2007).

Research into possible factors thought to underlie the relationship between rhythm instability and mood in bipolar disorder has been consistently advocated (Ankers & Jones, 2009; Grandin, Alloy & Abramson, 2006; Jones et al., 2005; Murray & Harvey, 2010). Whilst numerous studies have observed internally focussed cognitive styles within bipolar populations (Alatiq, Crane, Williams & Goodwin, 2010; Kelly, Mansell, Wood et al., 2011; Knowles, Tai, Jones et al., 2007; Mansell, Paszek, Seal et al., 2011), to date there has only been one investigation of how internal appraisal styles relate to circadian and social rhythm instability in bipolar disorder (Ankers & Jones, 2009). Ankers and Jones (2009) assessed levels of circadian and social rhythm instability, appraisal style, and mood in euthymic bipolar individuals versus individuals considered at behavioural high-risk. The high-risk participants exhibited higher levels of activated mood, greater variability in sleep patterns, weaker activity rhythms, and a stronger tendency to form positive, internal appraisals of experiences compared to the non-clinical controls. Furthermore, 80% of participants were correctly classified as high-risk or non-clinical control based on reported bedtime variability and the tendency to adopt a positive, internal appraisal style. These results indicate that rhythm instability and internal appraisal style, are strongly implicated in individuals at behavioural high-risk for bipolar disorder, emphasizing the need to explore relationships between these factors in clinical bipolar populations.

The current study combined the use of experience sampling methodology (ESM) with actigraphy to examine prospective relationships between rhythm instability, appraisal style and mood in everyday life. The study forms part of three separate PhD projects comparing mood experiences in individuals with bipolar disorder, individuals at behavioural high-risk and non-clinical controls. For the purposes of the present investigation, a third comparison group was examined consisting of individuals who had been diagnosed with fibromyalgia. Fibromyalgia is a musculoskeletal chronic pain disorder characterised by severe sleep disturbance, poor concentration and hyperalgesia (Mufson & Regestein, 1993). As fibromyalgia is associated with a similar severity of sleep disturbance to that observed in

bipolar disorder, comparisons were made between bipolar and fibromyalgia individuals to examine the extent to which rhythm instability, appraisal style and mood states are bipolar-specific.

6.2.1 Hypotheses

Hypothesis 1- Non-clinical controls will demonstrate better stability of circadian and social rhythms compared to high-risk, bipolar and fibromyalgia participants.

Hypothesis 2- Participants with a diagnosis of bipolar disorder will demonstrate a stronger tendency to adopt positive and negative internal appraisal styles compared to high-risk, fibromyalgia and non-clinical control participants.

Hypothesis 3- Participants with a diagnosis of bipolar disorder will demonstrate more intense and more variable mood states in comparison to high-risk, fibromyalgia and non-clinical control participants.

Hypothesis 4- Circadian and social rhythm instability will be positively associated with mood intensity and variability in bipolar disorder, such that individuals with disturbed rhythms will experience more intense and more variable mood states.

Hypothesis 5- Momentary, internal appraisal styles will be positively associated with momentary positive and negative moods in bipolar disorder, such that negative internal appraisals will be associated with increases in negative affect, and positive internal appraisals will be associated with increases in positive affect.

Hypothesis 6- The impact of rhythm instability upon mood in bipolar disorder will be further exacerbated by appraisal style, such that individuals who exhibit high levels of rhythm instability in addition to an internal appraisal style, will experience even more intense and variable mood states.

6.3 Method

6.3.1 *Experience Sampling Methodology (ESM)*

ESM involves the momentary assessment of phenomena in the context within which they naturally occur. Traditionally, ESM studies are conducted using paper and pencil diaries, whereby the participant is prompted multiple times over the course of a day to answer questions in the diary defined by the research team. Participants are usually given a watch to wear which has been programmed to beep on a semi-random schedule (i.e. within 90 minute epochs), signalling completion of the diary items. Whilst ESM is a fairly novel methodology, it has been successfully applied in a variety of populations including bipolar disorder, fibromyalgia and healthy non-clinical samples (Collip, Wigman, Myin-Germeys et al., 2013; Castilla, Botella, García-Palacios et al., 2012; Gruber, Kogan, Mennin & Murray, 2013; Havermans, Nicolson & Devries, 2007).

In the current study, participants were assessed using ESM for seven consecutive days, receiving 10 prompts each day between the hours of 8:00 and 22:00. Each participant was assigned to one of three schedules which had been created using a random number generator. Only the members of the research team knew which schedule had been assigned to each participant. This meant that participants could not anticipate when the next prompt would arrive, and therefore could not pre-empt their responses. Participants were given the choice of either receiving the prompts in the form of a text message sent to their mobile phone, or by wearing an analogue watch which had been programmed to beep on the same prompt schedule. In the case of using a mobile phone, the participant's mobile number was synced with a GoogleMail account. Using the free Google Calendar service, each prompt had been manually entered as an 'event' which provided a text message reminder (i.e. "Please fill in your diary").

After completing each diary entry, participants were asked to indicate the current time in hours and minutes. In accordance with standard procedures (Delespaul, 1995), any diary

entries which were completed more than 5 minutes before or more than 15 minutes after the scheduled prompt were excluded from the analyses. Furthermore, any participants who failed to respond to at least one third of the prompts (i.e. 23 out of 70) within this time frame, were excluded from the analyses.

6.3.2 Power

The high degree of variation in how positive and negative moods are measured between ESM studies poses a challenge in terms of calculating effect sizes required to conduct a power analysis. Therefore in the present study, sample size was determined with reference to the number of participants recruited in similar studies, in addition to practical restrictions regarding the amount of actigraphy and ESM equipment available and the size of the research team. The majority of ESM studies assessing clinical populations use samples of 30 to 40 participants per group (Havermans, Nicolson, Berkhof & deVries, 2010; Thewissen, Bentall, Oorschot et al., 2011). With reported drop-out rates ranging between 10 and 20% in existing studies (deVries & Delespaul, 1989; Myin-Germeys, Delespaul & deVries, 2000; Morren, van Dulmen, Ouwerkerk & Bensing, 2009; Schneiders, Nicolson, Berkhof et al., 2007), a target sample size of 50 participants per group was used in the present investigation.

6.3.3 Measures

6.3.3.1 The Hypomanic Personality Scale (HPS; Eckblad & Chapman, 1986)

The HPS is commonly used to identify individuals at high behavioural risk for bipolar disorder. The questionnaire consists of 48 true or false statements with high scores indicating the presence of hypomanic personality traits such as impulsivity and creativity (Eckblad & Chapman, 1986). A test-retest reliability of 0.81 has previously been reported, in addition to an internal consistency of 0.87 (Eckblad & Chapman, 1986).

6.3.3.2 The Social Rhythm Metric (SRM; Monk et al., 1990)

The SRM is a 17 item questionnaire which provides an indication of an individual's social rhythm regularity. Respondents are required to complete the SRM each day for seven days, indicating whether or not they have performed each of the 17 activities and, if applicable, the time at which the activity was performed. Two items are optional, allowing participants to report additional activities which they have performed. In the present study, these two items were not included in the total score calculations due to concerns regarding reporting variability between participants. Total scores on the SRM range from 0 to 7, with higher scores indicating greater regularity. Although estimates of the internal consistency of the SRM have not been reported, the measure has been found to demonstrate acceptable test re-test reliability ($r=.44$; Monk et al., 1990).

6.3.3.3 Sleep Log

In line with previous research, participants completed a sleep log alongside wearing the actiwatch (Ankers & Jones, 2009; Harvey et al., 2005; Millar, Espie & Scott, 2004). This included the time they went to bed the previous night (bedtime), the time they fell asleep (sleep time), the time they became awake that morning (wake time), and the time at which they got out of bed (get-up time). Additionally, participants rated how well they felt they had slept the previous night on a scale from 1 (Not very well at all) to 10 (Very well), to provide a subjective measure of sleep quality. Participants were also asked to report periods during the day when they had not been wearing the actiwatch (e.g. if in contact with water), so that these periods could be excluded from the analysis.

To assess sleep pattern variability, four sleep variability variables were created based upon standard deviations of self-reported bed-times (bedtime variability), sleep times (sleep time variability), wake times (wake time variability) and get-up times (get-up time variability) across the study week.

6.3.3.4 Actigraphy

Actigraphy permits the objective assessment of activity and sleep patterns over multiple days, weeks and even months. Participants are asked to wear an ‘actiwatch’; a non-invasive, watch-like device containing a small accelerometer. Worn on the non-dominant-wrist, the actiwatch records and stores the participant’s physical movements in epochs. This data is then downloaded from the watch and analysed using sleep analysis software. Non-parametric circadian rhythm analyses may also be conducted using actigraphy software, to generate indices of activity rhythm variability, stability and amplitude (CamNTEch, 2003).

In the current study, two actiwatch models were used; the Actiwatch 2 (Phillips Respironics) and the Actiwatch 4 (Cambridge Neurotechnology Ltd). Actiwatch 2 models were programmed using Respironics Actiware software (version 5.70.1) whilst Actiwatch 4 devices were programmed using CamNTEch Actiwatch Sleep Analysis software (version 1.19).

All actiwatches were programmed to start recording the night before the first day of the ESM assessment period. Each actiwatch was set to record at 15 second epochs over 7 consecutive days and nights. Self-reported bed-times and get-up times were entered using the actigraphy software to signify the start and end of each rest period. Sleep onset and offset was then automatically determined using the sleep scoring algorithm. Briefly, the algorithm compares activity values within one minute of the current epoch to determine whether or not the participant was awake or asleep at that moment.

In the present study, the following variables were calculated from the actigraphy data:

- Sleep Duration: time between sleep onset and sleep offset.
- Sleep Onset Latency: time taken to fall asleep once in bed.
- Sleep Efficiency: percentage of time scored as ‘sleep’ during the rest period.

- **Sleep Fragmentation:** reflects the amount of movement during the sleep period. It is the percentage of immobility periods shorter than 1 minute, as a proportion of the total number of mobility periods.
- **Relative Amplitude:** reflects the amplitude of the activity rhythm. It is the difference between average activity during the most active 10 hour period, and average activity during the least active 5 hour period. Scores range from 0 to 1, with higher scores indicating higher rhythm amplitude.
- **Intradaily Variability:** reflects the degree of fragmentation of activity rhythms within days. Scores range from 0 to 2, with higher scores indicating greater fragmentation.
- **Interdaily Stability:** reflects the degree of similarity in activity rhythms between days. Scores range from 0 to 1, with higher scores indicating greater stability.
- **Actigraphy Sleep Time Variability:** standard deviation of actigraphy-detected sleep times across the week.
- **Actigraphy Wake Time Variability:** standard deviation of actigraphy-detected wake times across the week.

6.3.3.5 *The ESM Diary*

Participants were given seven identical diaries for the duration of the study week. Each diary contained 10 identical sets of questions relating to current thoughts, mood, appraisal style and contextual factors.

Positive and negative affect were assessed by six items; three reflecting positive affect (i.e. cheerful, energetic, and confident), and three reflecting negative affect (i.e. bad about myself, down, and guilty). Selection of the items was based upon a factor analysis of items measuring positive and negative affect (Havermans et al., 2010), in addition to items which

had been used in previous ESM studies (Myin-Germeys, Peeters, Havermans et al., 2003; Wichers, Myin-Germeys, Jacobs et al., 2007). Each item was answered on a 1 to 7 point Likert scale ranging from 'Not' to 'Very'. Participants were instructed to focus on their mood just before receiving the prompt, rather than in the current moment, as recommended by Palmier-Claus, Myin-Germeys, Barkus et al. (2011).

In order to assess positive and negative appraisal styles, two items taken from the Hypomanic Interpretations Questionnaire (HIQ; Jones, Mansell & Waller, 2006a) and Interpretations of Depression Questionnaire (IDQ; Jones & Day, 2008) respectively, were incorporated into the diary. Due to the trait-style format of the HIQ and IDQ, the items were re-worded to reflect momentary appraisals (i.e. "Right now I am in high spirits and full of energy. I feel like this because...", and "Right now I am feeling down on myself, I feel like this because..."). Participants rated the extent to which they agreed with each statement on a 1 to 4 point Likert scale ranging from 'Not at all' to 'A great deal'.

Participants were also instructed to rate the extent to which they felt comfortable and threatened in the company of the persons present when completing each diary entry, in addition to the extent to which the current prompt had irritated them. These items were assessed on a 1 to 7 point Likert scale ranging from 'Not' to 'Very'.

6.3.4 Participants

Participants were recruited via local newspaper adverts, internet forums and social media web pages. Clinical participants were also recruited from GP surgeries, support groups and community mental health teams. A large proportion of the non-clinical sample had previously taken part in an online survey study (see Chapter 5) which provided details about the present investigation.

Eligible participants were individuals aged 18 and over who were able to provide informed consent and communicate in English at a sufficient level. Night shift workers were ineligible due to the associated disruption to circadian and social rhythms (Zee & Turek, 2013). Individuals who demonstrated high suicidal intent or met Structured Clinical Interview for DSM-IV Disorders-Longitudinal Interval Follow-Up Evaluation (SCID-LIFE; Keller, Lavori, Friedman et al., 1987) criteria for a current manic, hypomanic, mixed affective or major depressive episode within the previous 4 weeks, were ineligible due to the nature of the study. Any individuals who had experienced a physical brain injury and/or received a diagnosis of dementia were also ineligible.

Bipolar participants who; i) did not meet Structured Clinical Interview for DSM-IV Disorders (SCID; First, Spitzer, Gibbon, et al., 1997) criteria for a primary diagnosis of bipolar I or II disorder, or; ii) had a current diagnosis of a chronic pain disorder, were excluded. Non-clinical participants were ineligible if they; i) had been diagnosed with a mental health problem and/or sleep disorder within the preceding 2 years; ii) had a current diagnosis of a chronic pain disorder, or; iii) had experienced significant and prolonged sleep disturbance within the past month. Non-clinical and fibromyalgia participants who had been diagnosed with a serious and enduring mental health problem, or met SCID criteria for a previous manic, hypomanic or mixed affective episode, were also excluded (N.B. those who met SCID criteria for a previous major depressive episode were not excluded). Fibromyalgia participants who had not received a formal diagnosis from a health professional were also ineligible.

As the majority of non-clinical participants had previously completed the HPS for the purposes of a previous study (see Chapter 5), the same cut-off scores for non-clinical control and high-risk groups were applied in the current investigation. Where participants had not completed the HPS previously, an electronic version of the measure was emailed to participants to complete. Non-clinical controls were individuals who scored between 0 and 15

on the Hypomanic Personality Scale (HPS; Eckblad & Chapman, 1987), whilst individuals with scores of 22 or above were classed as high-risk.

In total 50 bipolar, 38 fibromyalgia, 50 non-clinical controls and 3 high-risk individuals took part in the wider investigation (see Figure 1). For the purposes of the present study, four bipolar participants were excluded due to reporting the presence of a comorbid chronic pain disorder. Of the seventy-five referrals received from the non-clinical population, just three met criteria for being at behavioural high-risk for bipolar disorder based on their HPS scores. Due to the small number of high-risk participants it was decided that including this group in the statistical analyses would be inappropriate, therefore data regarding this group are not presented.

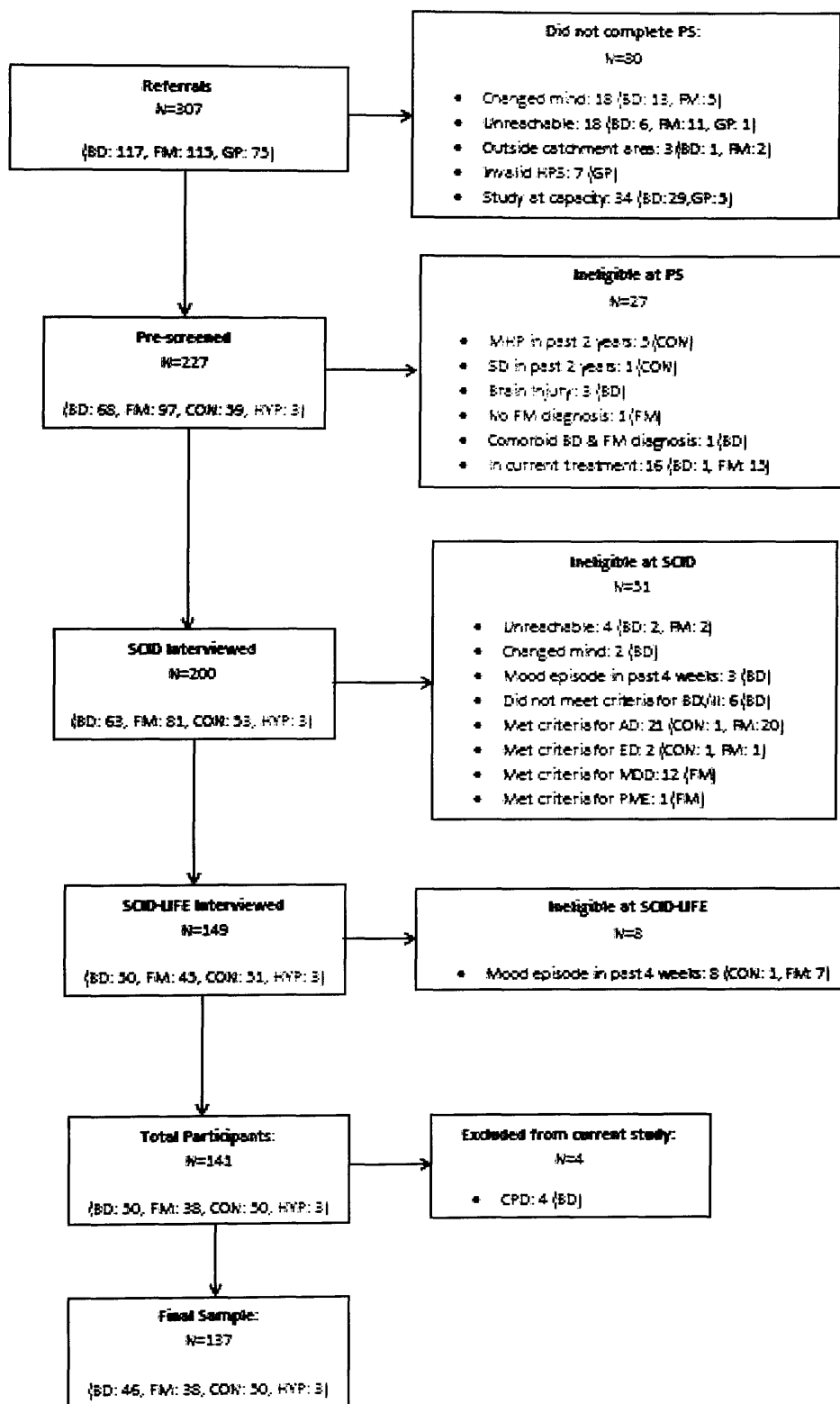


Figure 1. Process of Participant Selection

Note: BD= Bipolar Disorder; FM= Fibromyalgia; GP= General population; CON= Control; HYP= Behavioural high-risk; MHP= Mental health problem; SD= Sleep disorder; AD= Anxiety Disorder; ED= Eating Disorder; MDD= Major Depressive Disorder; PME= Past Manic Episode; CPD= Chronic pain disorder.

6.3.5 Procedure

Upon referral to the study, participants completed a telephone pre-screen with a member of the research team, all of whom had received training in conducting clinical interviews. Participants deemed eligible on the basis of their responses to the screening questions were then interviewed using the SCID to verify their mood eligibility based on the criteria outlined above. On completion of the SCID interview, a briefing appointment was arranged during which participants were interviewed using the SCID-LIFE to ensure that they had not met criteria for any DSM-IV mood episode since the initial SCID interview.

After completing the SCID-LIFE interview, participants were briefed on how to wear the actiwatch, and how to complete the ESM diaries and SRM. Participants were instructed to respond to each ESM prompt as soon as possible, rather than mulling over their answers. This was to ensure that the data reflected the participants' most immediate responses. Participants were told that their responses would remain confidential, and therefore they should strive to be as honest as possible. During the briefing appointment it was emphasized that participants should only respond to the prompts when feasible, and not to try and adapt their daily routine or sleep pattern around completion of the diaries. Similarly participants were asked to put their phones on silent or put the ESM watch out of ear-shot during times when the prompt would disrupt their normal activities or sleep pattern (e.g. when taking an afternoon nap). Participants were instructed to wear the actiwatch at all times on their non-dominant wrist, only removing the actiwatch if they knew they would be in contact with water.

Over the course of the study week, participants were contacted by a member of the research team to ensure that they were following the procedure correctly, and also to answer any questions that the participant had. Upon completion of the seven day study period, participants were fully debriefed about the study, either in person or by telephone. All participants were given £10 as compensation for taking part, and later received feedback on their sleep and activity patterns over the study week based on the actigraphy recordings.

6.3.6 Statistical Analysis

Analyses were carried out using *R* (R Development Core Team, 2008). Data for all variables were normally distributed with the exception of self-reported and actigraphically measured bedtime variability and sleep onset latency, all of which were log transformed. Group comparisons were performed using chi-squared tests and analysis of variance. Post-hoc between-group comparisons were conducted using Student's *t*-test. Due to the number of comparisons made, in addition to uncertainty regarding statistical power, a conservative significance level of $p < .01$ was applied to all comparisons in attempt to reduce the risk of Type I error.

Gender was significantly associated with all rhythm instability variables ($p < .001$), and was therefore entered as a covariate in between-group analyses involving rhythm instability. Age and employment status also demonstrated significant correlations with measures of sleep disturbance. As such, age was entered as a covariate for between-group comparisons regarding actigraphy sleep and wake time variability, and sleep diary bed time, wake time, and get-up time variability. Employment status was entered as a covariate for between-group comparisons regarding sleep onset latency, sleep efficiency, sleep fragmentation, and sleep quality. For all multilevel modelling analyses involving between-group comparisons, age, gender and employment status were controlled for. As education was not significantly associated with the instability variables, this was not controlled for in any of the between-group analyses.

Momentary ratings of feeling threatened, comfortable and irritated were entered as covariates for all analyses which included affect intensity or variability as the outcome variable, in an attempt to control for the potential effects of these factors upon mood. Day of the week was also added as a covariate to control for any weekend effects.

Of the eleven measures of sleep disturbance included in the present study, sleep duration, actigraphic sleep and wake time variability and self-reported sleep quality, were

included as predictor variables in the within-group analyses. As current evidence regarding associations between sleep duration and mood in euthymic bipolar populations is inconsistent (see Chapter 2), sleep duration was included in the within-group analyses to explore relationships between momentary mood states and daily versus weekly measures of sleep duration. Actigraphy sleep and wake time variability were included in the analyses to provide an objective measure of sleep pattern variability, whilst self-reported sleep quality was included as a subjective measure of sleep disturbance, complimenting the objective sleep estimates provided by the actigraphy data. SRM score, relative amplitude, interdaily stability and intradaily variability, were also entered as rhythm instability predictor variables, representing the degree of social and activity rhythm instability respectively.

Although circadian rhythm instability was primarily assessed at the week level, for the purposes of assessing within-group relationships between affect and daily rhythm disturbance, daily measures of sleep quality and sleep duration were also included in the multilevel analyses.

6.3.6.1 Missing Data

6.3.6.1.1 Social Rhythm Metric

Where participants did not attempt to complete the SRM, exhibited consistent patterns of missing data (i.e. full days with no items completed, failing to complete particular items on at least 4 of the 7 days), or failed to provide the time at which activities were performed making the data unscorable, their SRM data was excluded from the analyses (see Figure 2). Of the remaining sample, only 34 completed the SRM in full (10 bipolar, 8 fibromyalgia, 16 non-clinical control), with the majority of participants failing to provide a yes/no response to at least one of the 15 items on at least one of the 7 days of the study (see Appendix 6). Missing values were imputed based upon the average number of ‘hits’ (i.e. activities

performed within 45 minutes of the habitual time) for the missing item on other days (see Monk, Kupfer, Frank & Ritenour, 1991 for a description of the SRM scoring method).

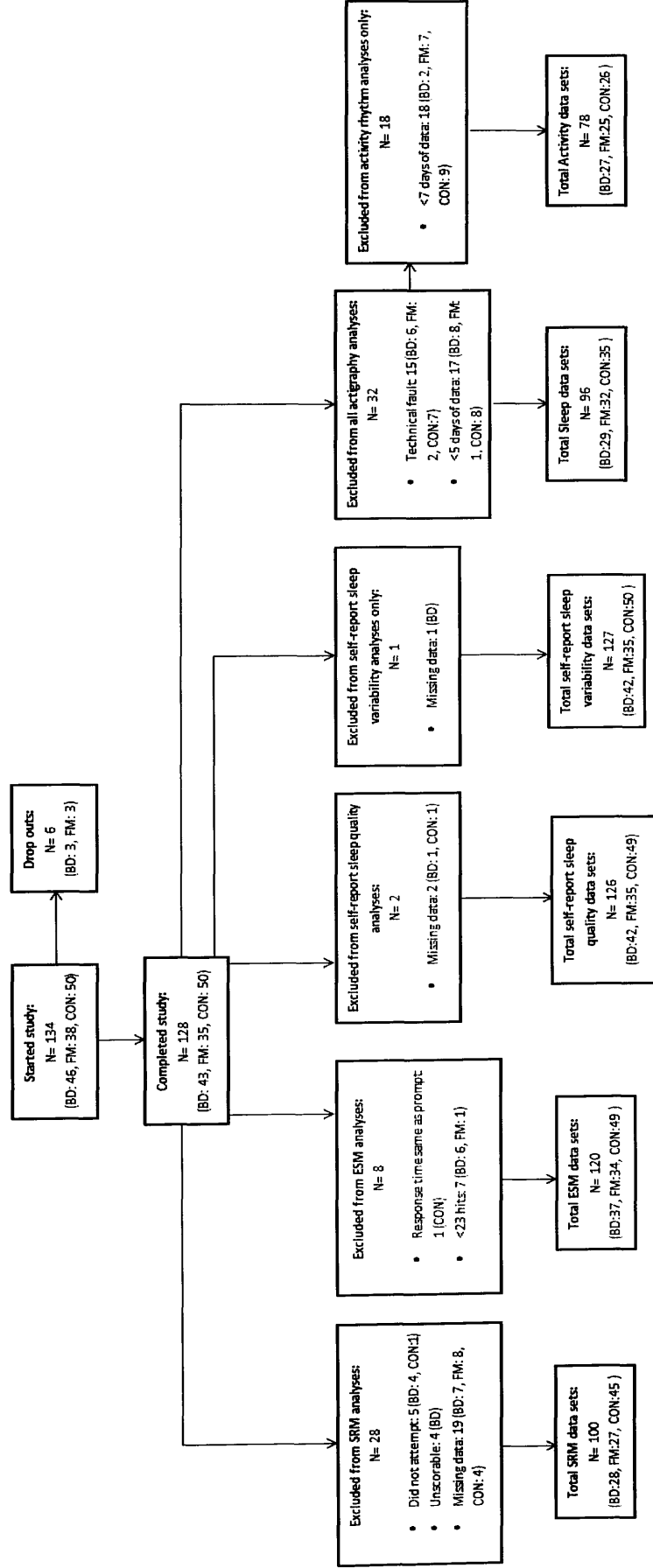


Figure 2. Process of final samples included in analysis.

Note: BD= Bipolar participants; FM= Fibromyalgia participants; CON= Non-Clinical Controls; HYP= High-risk participants.

6.3.6.1.2 Sleep and Activity

Fifteen data sets were excluded from the actigraphy analyses due to technical faults with the actiwatches, which raised concerns regarding the validity of the data (see Figure 2). In line with the recommendation that actigraphic sleep estimates should be based upon five to seven consecutive days and nights of recording to achieve adequate validity (Acebo, Sadeh, Seifer et al., 1999), any participants who did not provide at least 5 consecutive days of data were excluded. Where participants provided less than 5 consecutive days of data, this was either due to low battery life restricting the recording period ($n=6$), or due to participants failing to wear the watch for at least 5 consecutive days and nights ($n=11$).

Participants who provided less than seven days of actigraphy data were excluded from the activity rhythm analysis on the grounds that reliable estimates of activity rhythms require recording over at least seven consecutive days and nights (Van Someren, 2007). Where participants provided less than 7 consecutive days of data, this was either due to low battery life restricting the recording period ($n=4$), or due to participants failing to wear the watch for at least 7 consecutive days and nights ($n=14$).

Where participants had not completed the bedtime and/or get-up time items of the sleep diary, data from the “Get out of bed” and “Go to bed” items of the SRM were imputed. Comparison of self-reported bedtimes and get-up times based on the SRM versus the sleep diaries, revealed a mean difference of 3 minutes and 1.8 minutes respectively, justifying this approach. SRM data was substituted for missing sleep diary data in seven cases (3 bipolar, 1 fibromyalgia and 3 non-clinical controls). One participant had neither completed the two sleep items from the SRM, nor the bedtime and get-up times in the sleep diary, and was therefore excluded from analyses involving self-reported sleep variability (see Figure 2). Two participants failed to complete the sleep quality item in the sleep diaries and were therefore excluded from analyses relating to self-reported sleep quality.

Sleep diary and actigraphy-based bedtimes correlated highly across the sample ($r = .88$, $p < .001$), as did sleep diary and actigraphy-based get-up times ($r = .77$, $p < .001$). However, three participants reported bedtimes/get-up times which differed by those generated by the actigraphy software by at least 30 minutes on at least 3 occasions (2 bipolar and 1 fibromyalgia). Therefore group comparisons involving self-reported bedtime and get-up times were performed twice; firstly with all of the data and secondly excluding these participants.

Where participants did not provide self-reported off-wrist periods in the ESM diary, off-wrist periods were obtained from the actigraphy recordings ($n=2$). Similarly, where self-reported off-wrist periods differed from those indicated by the actigraphy recordings by at least 30 minutes, participants were contacted to enquire about these periods (e.g. to check if the participant had taken off the watch but had put it in their handbag). Where off-wrist periods remained ambiguous (i.e. if participant was unreachable, or couldn't remember, or still maintained what they had written in diary), these periods were determined based upon actigraphy recordings ($n=13$).

All group comparisons involving sleep and activity variables were run twice; first with all of the data, and second excluding data sets containing self-reported bedtimes and get-up times which had been imputed from the SRM or actigraphy recordings. Any data sets containing self-report times which differed significantly from those generated by the actigraphy software as described above, were also excluded for the second round of analyses.

6.3.6.2 *ESM*

Thirteen participants were excluded from the ESM analyses due to failing to adhere to the ESM protocol as previously described (see Figure 2). One non-clinical control participant was also excluded due to self-reported entry completion times being the same as the time at which the prompts were received, raising concerns about the validity of the data.

Across the sample, positive correlations were observed between the three positive affect items ($r=.45$ to $.80$) and also between the three negative affect items ($r=.47$ to $.83$). Therefore, scores on the individual items were averaged to form composite measures of positive and negative affect intensity (i.e. PA and NA respectively). Mean differences in composite PA and NA between observations were used as a measure of affect variability across the week.

6.3.6.3 Multilevel Modelling

ESM data have a hierarchical structure, providing measurements of a given phenomenon at the prompt level, day level and participant level. Due to the nested nature of ESM data, multiple regression analysis is not appropriate as observations are not independent and violate the homogeneity of variance assumption (Palmier-Claus et al., 2011; Tabachnick & Fidell, 2001). Therefore in the present study, multilevel regression analyses were performed to account for the variability within each level.

Nested models which differed with regard to the structure of the random effects (i.e. participant, day within participant, and time between prompts) were compared with one another using the Akaike Information Criterion. Conditional on participant and day, modelling the temporal correlation between observations did not improve the model fit. Therefore this correlation term was excluded, and analyses were conducted using the model that contained independent random effects for participant and day within participant.

For the purposes of testing hypothesis 5, momentary scores on the internal appraisal items were entered as predictor variables in the multilevel regression models to assess relationships between internal appraisal style and intensity and variability of momentary affect in the bipolar sample. To test hypothesis 6, all ten measures of rhythm instability, in addition to the daily and weekly measures of internal appraisal style, were entered simultaneously as predictor variables within the models for PA and NA intensity and variability within the

bipolar sample. To examine the moderating effect of internal appraisal style, interactions between each appraisal variable and each instability variable were added to the models.

6.4 Results

6.4.1 Description of Groups

The sociodemographic characteristics of each group are presented in Table 1. There were no significant differences in ethnicity between the three groups. However, the groups differed significantly with regard to gender ($\chi^2(2, N=134) = 15.64, p < .001$), age ($F(2, 131) = 20.92, p < .001$), and employment status ($\chi^2(6, N=128) = 57.28, p < .001$). A greater proportion of the bipolar group were male compared to the non-clinical control and fibromyalgia groups, and fibromyalgia participants were significantly older on average compared to bipolar participants and non-clinical controls. A considerably larger proportion of the bipolar and fibromyalgia groups were retired or unemployed in comparison to the non-clinical control group, of which the majority were in full-time employment.

The groups also differed on level of education ($\chi^2(4, N=133) = 25.55, p < .001$), with a greater proportion of the non-clinical control sample achieving qualifications in higher education compared to the two clinical groups.

In comparison to the bipolar and non-clinical control groups, a greater proportion of the fibromyalgia sample reported taking medication for physical health complaints ($\chi^2(2, N=134) = 29.80, p < .001$). Furthermore, a higher number of fibromyalgia participants reported taking anti-depressant medication in contrast to bipolar participants ($\chi^2(2, N=134) = 41.90, p < .001$). It is probable that the low rate of anti-depressant medication use in the bipolar sample relative to fibromyalgia participants, reflects the additional use of mood-stabilising medication.

The majority of bipolar participants met SCID criteria for Bipolar I Disorder, with only 9 individuals meeting criteria for Bipolar II Disorder. Almost half of the bipolar sample met SCID criteria for a comorbid anxiety disorder.

Upon entering the study, participants were asked if they had ever received psychological treatment which addressed their sleep patterns or daily routines. None of the non-clinical control sample, and only five participants from the bipolar sample (10.9%), reported receiving such treatment. One participant from the fibromyalgia sample (2.6%) also responded positively to this question. Due to the low incidence of previous treatment regarding circadian and social rhythm stability, this factor was not controlled for.

Table 1. Sociodemographic characteristics

	BD (n=46)			FM (n=38)			CON (n=50)			Analysis
	N	%		N	%		N	%		
Gender (male)	19	41.3%		2	5.3%		10	20.0%		$\chi^2(2, N=134) = 15.64, p < .001$
Ethnicity*										
White British	42	91.3%		35	92.1%		48	96.0%		
Mixed White & Black Caribbean	1	2.2%		-			-			
Other White	2	4.3%		3	7.9%		2	4.0%		
Other Asian	1	2.2%		-			-			$\chi^2(2, N=132) = 0.73, p = .70$
Marital Status										
Single	17	37.0%		8	21.05%		13	26.0%		
Cohabiting	5	10.9%		2	5.3%		12	24.0%		
Married/ Civil Partner	13	28.2%		20	52.6%		21	42.0%		
Separated/ Divorced/ Widowed	11	23.9%		8	21.05%		4	8.0%		$\chi^2(6, N=134) = 15.03, p = .02$
Employment*										
Retired/ Unemployed	21	45.7%		26	68.4%		0	0%		
Volunteer	6	13.0%		0	0%		0	0%		
Student	2	4.3%		1	2.6%		7	14.0%		
Part-Time	9	19.6%		7	18.4%		11	22.0%		
Full-Time	8	17.4%		4	10.5%		32	64.0%		$\chi^2(6, N=128) = 57.28, p < .001$

Table 1. (continued)

Education*	BD (n=46)		FM (n=38)		CON (n=50)		Analysis
	N	%	N	%	N	%	
Primary	0	0%	1	2.6%	0	0%	
Secondary	9	19.5%	13	34.2%	1	2.0%	
Further	17	37.0%	10	26.3%	9	18.0%	
Higher	20	43.5%	14	36.8%	40	80%	$\chi^2(4, N=133)=25.55, p<.001$
Medication							
Other/physical	16	34.8%	31	81.6%	13	26%	$\chi^2(2, N=134)=29.80, p<.001$
Anti-depressant	17	37.0%	24	63.2%	-		$\chi^2(2, N=134)=41.90, p<.001$
Mood Stabiliser	28	60.9%	-		-		
Anti-psychotic	32	69.6%	-		-		
Hypnotic	9	19.6%	-		-		
SCID Diagnosis							
Bipolar I	37	80.4%	-		-		
Bipolar II	9	19.6%	-		-		
Comorbid AD	22	47.8%	-		-		
Comorbid BPD	1	2.2%	-		-		
Age (years)	Mean 43.89	SD 12.72	Mean 54.11	SD 13.01	Mean 37.68	SD 9.87	$F(2, 131)=20.92, p<.001$

Note: AD= Anxiety disorder (e.g. Social Phobia, Generalised Anxiety Disorder, Specific Phobia); BPD= Borderline Personality Disorder.

*For the purposes of the chi-squared test, categories with low expected counts were removed, i.e. participants who reported Other Asian/Mixed White and Black Caribbean ethnic backgrounds, reported being a volunteer, or reported ending education at primary level, were removed.

6.4.2 Between-Group Comparisons in Rhythm Instability

Sleep diary and actigraphy estimates of sleep across all three groups are presented in Tables 2 and 3 respectively. No significant differences were observed between groups on any of the self-reported sleep variability measures. However, non-clinical controls did report better sleep quality than both bipolar and fibromyalgia participants, demonstrating a significant and large effect (see Appendix 7). Self-reported sleep quality scores did not differ significantly between the two clinical groups. Although non-clinical controls reported less variable wake times over the study week compared to the bipolar and fibromyalgia participants, this effect did not reach significance ($F(2, 117) = 4.37, p = .015$).

Between-group comparisons of objective actigraphy sleep estimates, indicated significant differences with regard to sleep efficiency and actigraphy sleep and wake time variability (see Table 3). However, post-hoc comparisons revealed that none of the group differences in actigraphy sleep or wake time variability reached significance (see Appendix 7). It is noteworthy that although not statistically significant, the difference in sleep time variability between bipolar and non-clinical control participants represented a medium effect.

With regard to sleep efficiency, non-clinical controls demonstrated much higher scores in comparison to the two clinical groups, demonstrating a significant and large effect. Significant differences in sleep efficiency were not observed between the two clinical groups (see Appendix 7). Although group differences in sleep onset latency, sleep duration and sleep fragmentation demonstrated trends in the expected direction, none of these comparisons were significant at the $p < .01$ level.

As Table 4 shows, activity rhythms did not differ significantly between the three groups. However, data concerning relative amplitude and interdaily stability demonstrated non-significant trends in the expected direction.¹

No significant group differences in social rhythm regularity were observed (see Table 5), with all three groups exhibiting similar scores.

¹ Between-group comparisons regarding circadian and social rhythm instability were performed a second time, excluding those participants for whom missing or incongruent sleep diary data had been imputed as described previously. Excluding these participants did not affect the pattern of results, with the exception of relative amplitude and self-reported sleep quality. Although group differences in relative amplitude and sleep quality became statistically significant after excluding these participants, the difference in mean values before and after the exclusion of this data ranged from $-.02$ to $+.02$ for relative amplitude, and $-.02$ to $+.25$ for sleep quality. Due to the small differences in mean values, all subsequent analyses were performed solely with the full data set.

Table 2. Group means and standard deviations for sleep diary estimates of sleep.

	BD (N=42)	FM (N=35)	CON (N=50)	Group Difference
BTV	1.09 (0.76)	0.70 (0.54)	0.82 (0.49)	$F(2, 122)=2.87, p=.06$
STV	1.10 (0.60)	0.94 (0.64)	0.80 (0.51)	$F(2, 118)=2.99, p=.05$
WTV	1.11 (0.72)	1.12 (0.59)	0.99 (0.63)	$F(2, 117)=4.37, p=.015$
GTV	1.16 (0.78)	1.06 (0.62)	1.15 (0.54)	$F(2, 122)=1.28, p=.28$
SQ	5.99 (1.75) a	5.46 (1.47) a	7.11 (1.28) b	$F(2, 117)=13.38, p<.001$

Note: Post-hoc comparison: means with different subscripts differ significantly at $p<.01$. BTV= Bedtime Variability; STV= Sleep Time Variability; WTV= Wake Time Variability; GTV= Get-up Time Variability; SQ= Sleep Quality, based on participants' responses to the question 'How well did you sleep last night?' rated on a scale from 1 (Not very well at all) to 10 (Very well). STV comparison was a adjusted for gender. BTV, WTV and GTV comparisons were a adjusted for age and gender. SQ comparison was a adjusted for gender and employment. All mean values are unaadjusted.

Table 3. Group means and standard deviations for actigraphy estimates of sleep.

	BD (N= 29)	FM (N=32)	CON (N=35)	Group Difference
SOL (mins)	49.79 (39.30)	56.14 (40.68)	32.30 (22.14)	$F(2, 87)=4.78, p=.011$
Sleep Fragmentation (%)	18.24 (10.60)	17.63 (9.22)	12.97 (6.57)	$F(2, 87)=4.38, p=.02$
Sleep Duration (mins)	355.70 (115.37)	362.10 (113.71)	419.0 (62.14)	$F(2, 92)=4.14, p=.02$
Sleep Efficiency (%)	65.83 (19.40) a	64.76 (18.44) a	78.82 (11.13) b	$F(2, 87)=8.57, p<.001$
ASTV	1.21 (0.59) a	0.94 (0.62) ab	0.90 (0.51) b	$F(2, 91)=5.01, p=.009$
AWTV	1.32 (0.72) a	1.11 (0.75) a	1.08 (0.59) b	$F(2, 91)=5.41, p=.006$

Note: Post-hoc comparison: means with different subscripts differ significantly at $p<.01$. SOL= Sleep Onset Latency; ASTV= Actigraphy Sleep Time Variability; AWTV= Actigraphy Wake Time Variability. Sleep Duration comparison was a adjusted for gender. ASTV and AWTV comparisons were a adjusted for age and gender. SOL, Sleep Efficiency, and Sleep Fragmentation comparisons were a adjusted for gender and employment. All mean values are unaadjusted.

Table 4. Group means and standard deviations for actigraphy estimates of activity rhythms.

	BD (N= 26)	FM (N= 31)	CON (N= 27)	Group Difference
RA	0.83 (0.13)	0.85 (0.09)	0.90 (0.08)	$F(2, 74)= 2.94, p=.06$
IV	0.75 (0.19)	0.72 (0.19)	0.78 (0.21)	$F(2, 74)= 0.67, p=.51$
IS	0.53 (0.11)	0.58 (0.13)	0.58 (0.13)	$F(2, 74)= 1.52, p=.23$

Note: RA= Relative Amplitude; IV= Intradaily Variability; IS= Interdaily Stability. *F* statistic represents comparisons adjusted for gender, whilst mean values are unadjusted.

Table 5. Group means and standard deviations for Social Rhythm Metric scores.

	BD (N= 28)	FM (N= 27)	CON (N= 45)	Group Difference
SRM	3.66 (0.87)	3.94 (1.01)	3.98 (0.78)	$F(2, 96)= 1.31, p=.28$

Note: *F* statistic represents comparisons adjusted for gender, whilst mean values are unadjusted.

Table 6. Between-Group Effect Estimates for Internal Appraisal Style, Intensity of Affect and Variability of Affect

	β Estimate	95% CI	p value
ESM Appraisal Item:			
HIQ-H			
BD vs CON	0.03	-0.35 to 0.41	.88
FM vs CON	0.41	-0.03 to 0.86	.07
FM vs BD	0.38	-0.004 to 0.77	.05
IDQ-D			
BD vs CON	0.39	0.24 to 0.55	<.001
FM vs CON	0.03	-0.15 to 0.21	.75
FM vs BD	-0.37	-0.52 to -0.21	<.001
PA			
BD vs CON	-0.68	-1.16 to -0.21	.005
FM vs CON	-0.36	-0.92 to 0.19	.20
FM vs BD	0.32	-0.18 to 0.83	.21
NA			
BD vs CON	0.82	0.37 to 1.27	<.001
FM vs CON	-0.11	-0.63 to 0.42	.69
FM vs BD	-0.93	-1.40 to -0.46	<.001
PA.V			
BD vs CON	0.10	-0.03 to 0.23	.14
FM vs CON	0.06	-0.09 to 0.21	.43
FM vs BD	-0.04	-0.18 to 0.11	.62
NA.V			
BD vs CON	0.28	0.13 to 0.44	<.001
FM vs CON	-0.09	-0.28 to 0.09	.31
FM vs BD	-0.37	-0.54 to -0.21	<.001

Note: HIQ-H= Momentary HIQ-H score; IDQ-D= Momentary IDQ-D score; PA= Positive Affect; NA= Negative Affect; PA.V= Positive Affect Variability; NA.V= Negative Affect Variability.

6.4.3 Between-Group Comparisons of Internal Appraisal Style

The regression coefficients of the effect of group upon momentary internal appraisal styles are presented in Table 6. Bipolar participants demonstrated significantly higher scores on the IDQ-D item from moment to moment compared to the fibromyalgia and non-clinical control participants. Scores on the HIQ-H did not differ significantly between the three groups, although a non-significant trend for higher scores in the fibromyalgia group compared to the non-clinical control and bipolar groups was observed.

6.4.4 Between-Group Comparisons of Mood

No significant differences were observed between the non-clinical control and fibromyalgia participants on any measure of affect (see Table 6). Intensity and variability of NA was significantly higher in bipolar participants compared to the two comparison groups. Contrary to hypothesised effects, intensity of PA was significantly higher in non-clinical control participants compared to bipolar participants. PA intensity did not differ significantly between the two clinical groups. Differences in PA variability between bipolar participants and the two comparison groups were also not statistically significant.

Table 7. Fixed Effect Estimates of Associations between Affect and Rhythm Disturbance Internal Appraisal in the Bipolar Sample

Outcome Variable <i>β Estimate (95% CI)</i>	PA Intensity	PA Variability	NA Intensity	NA Variability
Predictor Variable				
Sleep Quality	0.23 (-0.47 to 0.93)	0.11 (0.03 to 0.20)	-0.23 (-0.99 to 0.54)	-0.02 (-0.41 to 0.37)
Sleep Duration	-0.003 (-0.02 to 0.01)	0.0004 (-0.002 to 0.002)	0.002 (-0.01 to 0.02)	0.002 (-0.006 to 0.009)
SQD	0.06 (-0.02 to 0.13)	-0.004 (-0.04 to 0.04)	-0.01 (-0.08 to 0.06)	-0.009 (-0.06 to 0.04)
SDD	-0.0004 (-0.002 to 0.001)	0.00008 (-0.0006 to 0.0008)	0.002 (0.0005 to 0.003)	0.0006 (-0.0003 to 0.001)
ASTV	0.18 (-1.73 to 2.09)	0.15 (-0.08 to 0.38)	0.30 (-1.79 to 2.38)	-0.01 (-1.08 to 1.06)
AWTV	0.99 (-1.05 to 3.03)	-0.18 (-0.46 to 0.10)	-0.03 (-2.25 to 2.19)	-0.58 (-1.72 to 0.56)
RA	-0.71 (-18.04 to 16.62)	-0.57 (-2.78 to 1.65)	0.83 (-18.08 to 19.74)	-1.03 (-10.69 to 8.64)
IS	-3.40 (-17.67 to 10.87)	-2.28 (-4.26 to -0.29)	4.79 (-10.70 to 20.29)	1.15 (-6.87 to 9.17)
IV	-2.17 (-8.28 to 3.93)	-0.60 (-1.37 to 0.16)	2.74 (-3.94 to 9.42)	-0.08 (-3.48 to 3.31)
SRM	1.28 (-1.23 to 3.79)	0.06 (-0.32 to 0.44)	-1.02 (-3.75 to 1.71)	-0.58 (-1.20 to 0.84)
HIQ-H	0.78 (0.69 to 0.88)*	-0.08 (-0.16 to -0.005)	-0.36 (-0.45 to -0.27)*	-0.14 (-0.22 to -0.06)*
IDQ-D	-0.63 (-0.73 to -0.52)*	0.14 (0.05 to 0.23)*	0.64 (0.55 to 0.72)*	0.13 (0.04 to 0.22)*
HIQ-HW	-0.05 (-0.92 to 0.82)	0.04 (-0.32 to 0.41)	-0.31 (-1.07 to 0.45)	-0.22 (-0.66 to 0.23)
IDQ-DW	-0.66 (-1.52 to 0.20)	0.15 (-0.18 to 0.48)	0.62 (-0.14 to 1.37)	-0.11 (-0.52 to 0.30)
HIQ-HD	1.27 (0.93 to 1.60)*	-0.03 (-0.28 to 0.22)	-0.53 (-0.79 to -0.26)*	-0.10 (-0.38 to 0.18)
IDQ-DD	-0.01 (-0.33 to 0.31)	0.04 (-0.21 to 0.28)	1.20 (0.94 to 1.45)*	0.38 (0.10 to 0.65)*

Note: Sleep Duration and Sleep Quality reflect averages over the week. SQD= Daily Sleep Quality; SDD= Daily Sleep Duration; ASTV= Actigraphy Sleep Time Variability; AWTV= Actigraphy Wake Time Variability; RA= Relative Amplitude; IS= Interdaily Stability; IV= Intradaily Variability; SRM= Social Rhythm Metric score; HIQ-H= Momentary HIQ-H scores; IDQ-D= Momentary IDQ-D scores;

HIQ-HW= Weekly average HIQ-H; IDQ-DW= Weekly average IDQ-D; HIQ-HD= Daily average HIQ-H; IDQ-DD= Daily average IDQ-D. Day of the week, irritation caused by the prompt, and feeling threatened/comfortable in present company, were entered as covariates.

* $p < .01$

6.4.5 Relationships Between Rhythm Instability, Appraisal Style and Mood in Bipolar Disorder

The regression coefficients presented in Table 7 represent the individual effects of the rhythm instability and internal appraisal variables upon momentary intensity and variability of PA and NA within the bipolar sample. None of the rhythm instability predictor variables were significantly related to the intensity or variability of PA and NA, at the $p < .01$ level. However, internal appraisal styles demonstrated significant associations with PA and NA. One unit increases in momentary HIQ-H scores were associated with increases in PA of 0.78, and decreases in NA of 0.36. Similar effects were observed regarding the relationship between daily average HIQ-H scores and affect intensity (see Table 7). In contrast, one unit increases in momentary IDQ-D scores were associated with decreases in PA of 0.63, and increases in NA of 0.64. Internal appraisal styles were also significantly associated with affect variability, such that increases in IDQ-D were associated with increases in variability of PA ($\beta = 0.14$, $p < .01$) and NA ($\beta = 0.13$, $p < .01$). Increases in daily average IDQ-D were also associated with increases in variability ($\beta = 0.38$, $p < .01$) and intensity ($\beta = 1.20$, $p < .01$) of NA. Momentary HIQ-H scores were associated with less variability in NA ($\beta = -0.14$, $p < .01$), however the relationship between momentary HIQ-H and PA variability was not statistically significant ($p = .04$).

Table 8. Estimates of the interaction term fixed effects for mood intensity and variability.

	β	CI	<i>p</i>
<u>PA</u>			
Predictor			
Model 1(a)			
SQ*HIQ-HW	0.25	-0.08 to 0.58	.14
Model 1(b)			
SD*HIQ-HW	-0.0005	-0.01 to 0.010	.93
Model 1(c)			
ASTV*HIQ-HW	-0.94	-2.27 to 0.39	.16
Model 1(d)			
AWTV*HIQ-HW	0.29	-1.31 to 1.90	.71
Model 1(e)			
RA*HIQ-HW	-1.85	-16.17 to 12.48	.79
Model 1(f)			
IS*HIQ-HW	1.23	-9.93 to 12.38	.82
Model 1(g)			
IV*HIQ-HW	1.56	-4.70 to 7.82	.61
Model 1(h)			
SRM*HIQ-HW	-0.32	-1.47 to 0.83	.57
Model 2(a)			
SQ*IDQ-DW	-0.35	-0.88 to 0.18	.19
Model 2(b)			
SD*IDQ-DW	0.002	-0.007 to 0.01	.65
Model 2(c)			
ASTV*IDQ-DW	1.18	-0.65 to 3.00	.19
Model 2(d)			
AWTV*IDQ-DW	-0.03	-0.92 to 0.86	.95

Table 8. *(continued)*

	β	CI	<i>p</i>
<u>PA</u>			
Predictor			
Model 2(e)			
RA*IDQ-DW	-3.05	-13.33 to 7.23	.54
Model 2(f)			
IS*IDQ-DW	-5.92	-14.01 to 2.16	.14
Model 2(g)			
IV*IDQ-DW	3.41	-3.43 to 10.25	.31
Model 2(h)			
SRM*IDQ-DW	-0.18	-0.84 to 0.48	.57
Model 3(a)			
SQD*HIQ-HD	0.003	-0.06 to 0.06	.91
Model 3(b)			
SDD*HIQ-HD	-0.0006	-0.002 to 0.001	.47
Model 4(a)			
SQD*IDQ-DD	0.05	-0.07 to 0.16	.43
Model 4(b)			
SDD*IDQ-DD	-0.003	-0.004 to -0.001	.002
<u>NA</u>			
Predictor			
Model 5(a)			
SQ*HIQ-HW	-0.03	-0.47 to 0.41	.88
Model 5(b)			
SD*HIQ-HW	0.005	-0.008 to 0.02	.44

Table 8. (continued)

	β	CI	<i>p</i>
<u>NA</u>			
Predictor			
Model 5(c)			
ASTV*HIQ-HW	0.45	-1.35 to 2.25	.61
Model 5(d)			
AWTV*HIQ-HW	1.28	-0.47 to 3.04	.14
Model 5(e)			
RA*HIQ-HW	15.26	1.21 to 29.30	.03
Model 5(f)			
IS*HIQ-HW	-1.36	-13.50 to 10.79	.82
Model 5(g)			
IV*HIQ-HW	-4.97	-11.40 to 1.47	.12
Model 5(h)			
SRM*HIQ-HW	0.59	-1.04 to 2.21	.46
Model 6(a)			
SQ*IDQ-DW	0.27	-0.17 to 0.72	.22
Model 6(b)			
SD*IDQ-DW	-0.003	-0.009 to 0.004	.46
Model 6(c)			
ASTV*IDQ-DW	-0.63	-2.19 to 0.93	.41
Model 6(d)			
AWTV*IDQ-DW	0.009	-0.75 to 0.77	.98
Model 6(e)			
RA*IDQ-DW	3.85	-4.97 to 12.68	.37
Model 6(f)			
IS*IDQ-DW	7.32	0.95 to 13.69	.03

Table 8. *(continued)*

	β	CI	<i>p</i>
<u>NA</u>			
Predictor			
Model 6(g)			
IV*IDQ-DW	-4.04	-9.69 to 1.61	.15
Model 6(h)			
SRM*IDQ-DW	0.23	-0.32 to 0.79	.39
Model 7(a)			
SQD*HIQ-HD	0.03	-0.04 to 0.09	.42
Model 7(b)			
SDD*HIQ-HD	-0.003	-0.005 to -0.001	.0007
Model 8(a)			
SQD*IDQ-DD	-0.06	-0.14 to 0.02	.15
Model 8(b)			
SDD*IDQ-DD	0.001	-0.0001 to 0.002	.08
<u>PA.V</u>			
Predictor			
Model 9(a)			
SQ*HIQ-HW	-0.02	-0.12 to 0.08	.68
Model 9(b)			
SD*HIQ-HW	0.0005	-0.003 to 0.004	.77
Model 9(c)			
ASTV*HIQ-HW	-0.10	-0.49 to 0.28	.58
Model 9(d)			
AWTV*HIQ-HW	0.19	-0.27 to 0.65	.40

Table 8. *(continued)*

	β	CI	<i>p</i>
<u>PA.V</u>			
Predictor			
Model 9(e)			
RA*HIQ-HW	1.48	-3.13 to 6.09	.51
Model 9(f)			
IS*HIQ-HW	-1.12	-4.56 to 2.31	.50
Model 9(g)			
IV*HIQ-HW	-0.58	-2.40 to 1.24	.51
Model 9(h)			
SRM*HIQ-HW	-0.02	-0.38 to 0.33	.90
Model 10(a)			
SQ*IDQ-DW	-0.02	-0.15 to 0.12	.77
Model 10(b)			
SD*IDQ-DW	-0.001	-0.003 to 0.0008	.22
Model 10(c)			
ASTV*IDQ-DW	-0.04	-0.47 to 0.39	.85
Model 10(d)			
AWTV*IDQ-DW	0.10	-0.14 to 0.35	.40
Model 10(e)			
RA*IDQ-DW	-1.01	-3.64 to 1.62	.43
Model 10(f)			
IS*IDQ-DW	0.92	-1.10 to 2.95	.35
Model 10(g)			
IV*IDQ-DW	-0.21	-1.95 to 1.53	.80
Model 10(h)			
SRM*IDQ-DW	0.16	-0.05 to 0.36	.13

Table 8. *(continued)*

	β	CI	<i>p</i>
<u>PA.V</u>			
Predictor			
Model 11(a)			
SQD*HIQ-HD	-0.03	-0.07 to 0.02	.23
Model 11(b)			
SDD*HIQ-HD	-0.0002	-0.001 to 0.0009	.72
Model 12(a)			
SQD*IDQ-DD	0.008	-0.06 to 0.07	.81
Model 12(b)			
SDD*IDQ-DD	-0.0004	-0.001 to 0.0005	.42
<u>NA.V</u>			
Predictor			
Model 13(a)			
SQ*HIQ-HW	-0.03	-0.15 to 0.09	.63
Model 13(b)			
SD*HIQ-HW	0.004	-0.0007 to 0.008	.09
Model 13(c)			
ASTV*HIQ-HW	0.06	-0.48 to 0.60	.83
Model 13(d)			
AWTV*HIQ-HW	0.34	-0.24 to 0.93	.24
Model 13(e)			
RA*HIQ-HW	1.45	-4.13 to 7.02	.59
Model 13(f)			
IS*HIQ-HW	-3.48	-7.78 to 0.83	.11
Model 13(g)			
IV*HIQ-HW	-0.03	-2.25 to 2.20	.98

Table 8. (continued)

	β	CI	<i>p</i>
<u>NA.V</u>			
Predictor			
Model 13(h)			
SRM*HIQ-HW	0.11	-0.37 to 0.58	.65
Model 14(a)			
SQ*IDQ-DW	0.18	0.02 to 0.35	.03
Model 14(b)			
SD*IDQ-DW	-0.003	-0.005 to -0.0002	.04
Model 14(c)			
ASTV*IDQ-DW	-0.37	-1.00 to 0.25	.22
Model 14(d)			
AWTV*IDQ-DW	-0.05	-0.38 to 0.27	.73
Model 14(e)			
RA*IDQ-DW	-0.60	-4.29 to 3.11	.74
Model 14(f)			
IS*IDQ-DW	3.003	0.23 to 5.77	.04
Model 14(g)			
IV*IDQ-DW	-1.31	-3.68 to 1.05	.26
Model 14(h)			
SRM*IDQ-DW	0.19	-0.08 to 0.45	.15
Model 15(a)			
SQD*HIQ-HD	-0.004	-0.05 to 0.04	.87
Model 15(b)			
SDD*HIQ-HD	-0.001	-0.002 to 0.0003	.13

Table 8. (continued)

	β	CI	<i>p</i>
Model 16(a)			
SQD*IDQ-DD	0.01	-0.06 to 0.08	.75
Model 16(b)			
SDD*IDQ-DD	-0.0008	-0.002 to 0.0003	.15

Note: PA= Momentary Positive Affect; NA= Momentary negative affect; PA.V= Positive Affect Variability; NA.V= Negative affect variability SQ= Sleep Quality weekly average; SD= Sleep Duration weekly average; HIQ-HW= HIQ-H Weekly average; IDQ-DW= IDQ-D Weekly average; ASTV= Actigraphy Sleep Time Variability; AWTV= Actigraphy Wake Time Variability; SQD= Sleep Quality Daily average; SDD= Sleep Duration Daily average; HIQ-HD= HIQ-H Daily average; IDQ-DD= IDQ-D Daily average.

The fixed effect estimates for each interaction term are presented in Table 8. Only two interaction terms were significantly associated with affect in the bipolar sample. Daily average IDQ-D scores demonstrated a significant moderating effect upon the relationship between daily sleep duration and PA intensity (see Model 4, Table 8), with the interaction term representing a larger negative effect upon PA intensity than the effect of daily sleep duration alone (see Table 7). The effect of the interaction between daily sleep duration and daily average HIQ-H scores upon NA intensity, was also statistically significant. However, the direction of the interaction effect was inconsistent with the independent effects of daily sleep duration and daily HIQ-H upon NA intensity.

Of the remaining non-significant effects, interactions between weekly average internal appraisal style and activity rhythm disturbance demonstrated the largest effects. For example, the interaction between interdaily stability and weekly average IDQ-D score was associated with a larger decrease in PA intensity than the effect of interdaily stability and weekly average IDQ-D alone (see Table 7). Weekly average IDQ-D scores also moderated the effect of interdaily stability upon NA intensity, such that the interaction term was associated with larger increases in NA intensity than the effect of the two predictor variables separately.

6.5 Discussion

Multilevel cognitive models of bipolar disorder suggest that internal cognitive styles interact with circadian and social rhythm disruption, contributing to extreme mood change (Jones, 2001; Mansell et al., 2007). Whilst available evidence indicates a cross-sectional relationship between rhythm instability, cognitive style and mood in individuals at behavioural high-risk for bipolar disorder (Ankers & Jones, 2009), it remains unclear how these factors interact within clinical populations.

6.5.1 *Circadian and Social Rhythm Instability*

We obtained partial support for our first hypothesis, with non-clinical controls demonstrating significantly higher levels of sleep efficiency and self-reported sleep quality, compared to bipolar and fibromyalgia participants. Similarly high levels of objective and subjective sleep disturbance in the bipolar and fibromyalgia groups, supports the claim that sleep disturbance may represent a transdiagnostic process across similarly chronic conditions (Harvey, 2009). Although differences in actigraphy sleep time variability between non-clinical control and bipolar participants did not reach significance, inspection of the effect sizes suggests that the study may have been underpowered to detect such an effect.

Whilst further research is required in this area, the results obtained in the current study suggest that individuals suffering from both psychological and physical chronic conditions, may benefit from interventions designed to improve sleep quality. Indeed recent research has demonstrated the positive effects of cognitive behavioural therapy for insomnia (CBT-I) in improving sleep quality in bipolar disorder (Kaplan & Harvey, 2013), fibromyalgia (Edinger, Wohlgemuth, Krystal & Rice, 2005), and cancer populations (Fleming, Randell, Harvey & Espie, 2014).

Although group differences on the other measures of sleep disturbance were not statistically significant, the data demonstrated a trend in the expected direction with bipolar and fibromyalgia participants exhibiting higher levels of sleep disturbance overall compared to the non-clinical controls. In comparison to similar studies, both the bipolar and non-clinical control samples in the current investigation demonstrated worse overall sleep disturbance as indicated by lower mean values of sleep efficiency and higher mean values of sleep onset latency (Ankers & Jones, 2009; Harvey et al., 2005; Jones et al., 2005; Millar et al., 2004; Ritter, Marx, Lewtschenko et al., 2012; Robillard, Naismith, Rogers et al., 2013). Comparison of the sociodemographic characteristics of the participants studied in the current investigation to those studied in previous investigations, did not reveal any systematic differences that could account for the poorer overall levels of sleep quality observed in the current study. The methods by which participants were identified also share similarity with previous investigations. This raises the possibility that the experience sampling method may have exacerbated sleep disruption in the current study. As the ESM prompts were received between 8am and 10pm each day, it is possible that the participants' sleep was disturbed during these times. Although participants were instructed to turn their mobile phones off or on silent if they did not wish to be disturbed, it is unclear whether or not participants remembered to do this.

In contrast to hypothesised effects, significant group differences in activity were not observed in the present study. Findings regarding intradaily variability and interdaily stability contradict those reported by Jones et al. (2005), who observed significantly higher intradaily and lower interdaily stability in euthymic bipolar individuals as compared to non-clinical controls. In the current investigation, bipolar participants demonstrated a non-significant trend for lower intradaily variability compared to non-clinical controls, indicating that activity rhythms were more fragmented in the non-clinical control group. However, the bipolar participants studied in the current investigation did demonstrate a non-significant trend for lower interdaily stability compared to non-clinical controls, in line with the results reported by Jones et al. (2005).

Although the non-clinical control and bipolar groups differed significantly with regard to age and gender in the current investigation, research suggests that gender is not significantly associated with intradaily variability (Huang, Liu, Wang et al., 2002). As age has been shown to positively correlate with intradaily variability (Huang et al., 2002; Luik, Zuurbier, Hofman et al., 2013), one would expect higher levels of intradaily variability in the bipolar group who were significantly older than the non-clinical controls in the current study. It is possible that the difference in findings between the two studies is related to differences in the clinical profiles of the bipolar samples. Of the bipolar participants studied by Jones et al. (2005), at least 89.5% were being treated with mood-stabilising medication in comparison to 60.9% of the bipolar participants studied in the present investigation. Mood stabilisers, such as lithium and carbamazepine, have been shown to increase levels of activity in depressed bipolar individuals (Joffe, Uhde, Post & Minichiello, 1987; Kupfer, Weiss, Foster et al., 1974) whilst weakening activity rhythms in manic individuals (Weiss, Foster, Reynolds & Kupfer, 1974). Lithium has also demonstrated a lengthening effect upon various circadian rhythms in human and animal populations (Klemfuss, 1992). Therefore, it is possible that the higher bipolar sample intradaily variability observed by Jones et al (2005), relates to the greater use of mood-stabilising medication in comparison to the bipolar sample examined in the current study. However, further research is required to fully explore the effects of psychotropic medication upon circadian rhythms in bipolar disorder specifically.

Whilst the lack of significant difference in relative amplitude between euthymic bipolar individuals and non-clinical controls corroborates findings reported by similar studies (Jones et al., 2005; Salvatore, Ghidini, Zita et al., 2008), more recent research has reported significant differences when amplitude is measured over 2 hour intervals using a complex equation referred to as the 'vulnerability index' (Indic, Murray, Maggini et al., 2012; Indic, Salvatore, Maggini et al., 2011). Indic and colleagues (2011) observed significantly higher vulnerability index scores in euthymic individuals with bipolar disorder compared to non-clinical controls. The results of the present study, in light of existing evidence, therefore

suggest that the assessment of activity rhythm amplitudes in individuals with and without bipolar disorder may require a more sensitive approach than simply comparing weekly average relative amplitude scores.

In the present study, all participants demonstrated SRM scores within the “normal” range (Monk et al., 1990) regardless of group membership. Three previous investigations have reported similar results (Bullock et al., 2011; Jones et al., 2005; Jones, Tai, Evershed et al., 2006b), suggesting that euthymic bipolar individuals do not exhibit significantly poorer social rhythm regularity in comparison to non-clinical controls from the general population. However, a number of studies report lower social rhythm regularity in euthymic bipolar individuals compared to non-clinical controls (Shen et al., 2008; Sylvia et al., 2009; Boland et al., 2012; St-Amand et al., 2013). It is difficult to interpret the results of the present investigation within the context of such conflicting evidence. However, comparison of effect sizes between studies indicates that studies reporting non-significant group differences in SRM score also lacked adequate power in comparison to those which reported significantly lower SRM scores in bipolar individuals. The effect size obtained in the present study ($d = -0.41$), indicates that a sample of 89 subjects per group would be necessary to achieve an adequate power of .80, assuming a significance level of $p < .01$. Therefore the non-significant group differences in SRM reported in the present study may represent Type II error. Furthermore, the small effect size obtained in the present study, and in previous studies, suggests that differences in social rhythm regularity between individuals with and without bipolar disorder represent a rather modest effect.

6.5.2 Internal Appraisal Style

As hypothesised, bipolar participants demonstrated a significantly stronger tendency to form momentary negative, internal appraisals of experiences compared to the fibromyalgia and non-clinical control participants. However, significant differences regarding the tendency

to adopt positive, internal appraisals were not observed. In contrast to our hypothesis, fibromyalgia participants demonstrated a non-significant trend for higher scores on the HIQ-H diary item compared to non-clinical controls and bipolar participants. As existing research concerning cognitive styles in fibromyalgia is severely lacking, interpretation of this unexpected finding is difficult. It is possible that the results relate to how internal appraisals were assessed. The ESM items were adapted from measures originally designed to assess trait rather than state appraisal style, raising concerns regarding the ability of these items to accurately assess concurrent appraisals from moment to moment. Furthermore, both positive and negative internal appraisal styles were assessed by singular items in the ESM diary. Although the items were selected on the basis of a principal components analysis conducted on the HIQ and IDQ, it is probable that these items in isolation were unable to capture all aspects of internal appraisal style which may differentiate bipolar from non-bipolar populations.

The stronger tendency to form negative but not positive internal appraisals in the bipolar group, is indicative of a pessimistic cognitive style. Similar findings have been reported by studies exploring attributional styles (Knowles et al., 2007) and extreme, conflicting appraisal styles (Kelly et al., 2011) in euthymic bipolar individuals versus non-clinical controls. The findings of the present investigation, in addition to the evidence described above, contradicts the view that positive, internal cognitive styles are more strongly related to bipolar vulnerability than negative cognitive styles (Jones et al., 2006a). It is possible that the stronger tendency to form negative, internal appraisals of experiences observed in the bipolar group, relates to problems with self-esteem as existing evidence indicates high self-esteem variability (Bentall, Myin-Germeys, Smith et al., 2011; Knowles et al., 2007; Neale, 1988) and low average levels of self-esteem (Blairy, Linotte, Souery et al., 2004) in euthymic bipolar populations. To explore this further it will be important for future studies to explore interactions between the intensity and variability of self-esteem and internal appraisal styles in bipolar and non-clinical control populations.

6.5.3 Intensity vs Variability of Positive and Negative Affect

As predicted, bipolar participants exhibited significantly higher levels of NA from moment to moment compared to non-clinical control participants, corroborating findings reported in existing ESM studies (Gruber et al., 2013; Havermans et al., 2010; Lovejoy & Steuerwald, 1995). However, a similar study by Myin-Germeys et al. (2003) reported non-significant differences in momentary NA between euthymic bipolar individuals and non-clinical controls. It is possible that the conflicting findings relate to differences in medication between the two bipolar samples, as almost all of the bipolar participants studied by Myin-Germeys et al. (2003) were being treated with mood-stabilising medication (i.e. 95%) in comparison to 60.9% in the current study. However, it will be important for future ESM studies to explore this issue further by examining the effects of different medication classes upon levels of momentary affect within euthymic bipolar samples.

Contrary to the findings reported by Gruber and colleagues (2013), bipolar participants also demonstrated greater NA variability in the present study. However, as participants were prompted to rate their current mood ten times each day compared to 24 times each day in the case of Gruber et al. (2013), it is possible that the difference in findings reflects differences in the intensity of ESM assessments (i.e., fluctuations in NA may be greater when affect is assessed every 60 to 90 minutes as in the current study, compared to every 30 minutes as in the latter study).

In contrast to predicted group differences in PA intensity, non-clinical control participants demonstrated significantly higher levels compared to bipolar participants. Whilst this finding corroborates the results reported by Havermans et al. (2010) and Myin-Germeys et al. (2003), other studies have reported non-significant group differences in PA between euthymic bipolar and non-clinical control populations (Gruber et al., 2013; Van der Gucht, Morriss, Lancaster et al., 2009). However, the data presented in the two latter studies does

represent a non-significant trend in the same direction. Viewed together with existing evidence, the results of the present study indicate that NA may be more strongly implicated in bipolar disorder than PA.

6.5.4 Relationship between Rhythm Instability, Appraisal Style and Mood in Bipolar Disorder

Contrary to our hypothesis, none of the rhythm instability measures demonstrated significant associations with affect intensity or variability within days in the bipolar sample. Similarly, previous night's sleep duration and self-reported sleep quality did not demonstrate significant associations with positive or negative affect the following day. Whilst similar studies have also reported non-significant relationships between mood and actigraphically-measured sleep duration and activity rhythms in euthymic bipolar samples (Gershon, Thompson, Eidelman et al., 2012; Jones et al., 2005), current evidence regarding the relationship between social rhythm regularity and mood is unclear. Only one previous study has reported findings regarding cross-sectional relationships between social rhythm regularity and mood in bipolar disorder, reporting that higher regularity scores corresponded to lower levels of depression (Shen et al., 2008). However, these findings are based upon a cyclothymic university student sample assessed over 2 weeks, and therefore direct comparison with the results observed in the present study may be inappropriate. In summary, whilst the results of the current study indicate that rhythm instability is not significantly related to positive or negative mood states during euthymia, similar research in this area is extremely limited and requires further attention.

As predicted, momentary internal appraisal styles were significantly related to momentary ratings of PA and NA within the bipolar sample. Although the size of the regression coefficients presented in Table 7 indicates a rather modest relationship between internal appraisal style and affect, appraisals of internal experiences are likely to occur frequently over the course of an average day and therefore the cumulative effects of a

momentary internal appraisal style may be much greater (Myin-Germeys et al., 2003). Furthermore, the size of the regression coefficients are comparable to those reported in similar ESM studies concerning cognitive processes in everyday life in bipolar disorder (Bentall et al., 2011; Gruber et al., 2013).

Positive, internal appraisals were associated with increases in PA intensity and decreases in NA intensity, whilst negative, internal appraisals were associated with decreases in PA intensity and increases in NA intensity. These findings compliment the results obtained from between-group comparisons of appraisal style and mood, and support the assumption that internally-focussed appraisals are associated with more intense mood states in bipolar disorder (Jones, 2001; Mansell et al., 2007).

The results also suggest that negative, internal appraisal styles may represent state-modulated trait variables in bipolar disorder (Clark & Goodwin, 2004), such that positive moods intensify positive appraisals whilst negative moods intensify negative appraisal. Following this line of reasoning, the stronger tendency to form negative internal appraisals in the bipolar group, combined with an absence of significant group differences in the tendency to form positive internal appraisals, may be related to the higher levels of self-reported negative affect in the bipolar sample. However, further research concerning the relationship between appraisal style and mood will be required to explore this issue fully.

Significant positive associations were also observed regarding negative, internal appraisals and the variability of both PA and NA in the bipolar sample. In contrast, positive internal appraisals were associated with less variability in PA and NA, however only the regression of HIQ-H upon NA variability was significant at the $p < .01$ level.

Viewed together, the results suggest that negative, internal appraisal styles in particular, are strongly related to the variability and intensity of day-to-day mood states in bipolar disorder. Both the variability and intensity of affective states have been associated with an increased risk of psychiatric axis 1 comorbidity in bipolar populations (Henry, Van

den Bulke, Bellivier et al., 2008). Affective lability has also been highlighted as a potential marker for bipolar vulnerability (Angst, Gamma & Endrass, 2003; Clayton, Ernst & Angst, 1994). The results of the present investigation therefore suggest that interventions which target negative, internal appraisal styles in euthymic bipolar populations, and perhaps non-clinical populations considered at-risk, may be effective in reducing the degree of affective variability. Further research into the relationship between internal appraisal styles and affect in these populations is therefore clearly warranted.

On the whole, the results of the multilevel modelling analysis did not indicate a significant moderating effect of internal appraisal style upon rhythm instability in the bipolar group, with many of the results failing to reach the required level of significance and/or demonstrating inconsistent effects. In light of the non-significant relationship observed between rhythm instability and affect, this is not surprising. However, a significant moderating effect of daily negative internal appraisal style was observed regarding the relationship between daily sleep duration and PA intensity. These findings suggest that state-like appraisal styles measured at the day level may play a prominent role in the intensity of momentary mood states day-to-day. However, it is possible that the study was underpowered to detect momentary moderation effects, emphasizing the need for further research in this area.

6.5.5 Limitations of the Current Study

The findings described above must be considered in light of several limitations. Firstly, positive and negative moods were assessed using self-report which is vulnerable to intra-individual interpretation variability and social desirability bias. Secondly, as participants responded to the ESM prompts using paper and pencil diaries, we cannot be sure that the diary entries were completed at the time at which the participants reported. This point is particularly relevant to participants who received prompts in the form of a text message which

displayed the time at which the prompt was received. Thirdly, medication effects were not controlled for in the analyses, therefore it is unclear whether observed differences between the bipolar and comparison groups reflect differences in bipolar versus non-bipolar populations or actually reflect differences in medicated versus non-medicated populations. The use of other drugs, such as caffeine and alcohol, were also not taken into account in the current study which may have had a significant influence upon circadian rhythms, appraisal and mood.

6.5.6 Conclusions

Poor sleep quality, but neither social rhythm regularity nor activity rhythm stability, was significantly associated with chronicity in the current study, with greater levels of sleep disturbance observed in the bipolar and fibromyalgia groups compared to the non-clinical controls. Contrary to predicted effects, bipolar participants did not exhibit a strong tendency to adopt positive, internal appraisals of experiences from moment to moment. Although the tendency to form negative internal appraisals of experiences correlated significantly with the variability and intensity of affective states in the bipolar sample, the results of the multilevel regression analysis did not indicate a moderating effect of appraisal style upon rhythm instability.

Overall the results obtained in the current study lend partial support to multilevel cognitive models of bipolar disorder, indicating significant relationships between internal appraisal styles and mood, but not between rhythm instability and mood. However, this is the first study to explore associations between circadian and social rhythm instability, and momentary mood states in bipolar disorder. A clearer understanding of the various factors implicated in bipolar mood change will be critical in informing psychological interventions not just for bipolar disorder, but for chronic conditions in general.

6.6 References

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Chapter 7: General Discussion

7.1 Overview

This chapter serves to integrate the findings of the studies presented, highlighting the implications and limitations of the research as a whole. The overarching aim of the present research was to explore relationships between circadian and social rhythm instability, appraisal style and mood during euthymia in bipolar disorder. It was reasoned that comparisons with populations at varying levels of vulnerability for bipolar disorder, would highlight underlying processes which differentiate individuals with bipolar disorder from those without, holding important implications for theory and practice. The initial phase of the research aimed to provide a broad, overall impression of the cross-sectional relationships between these factors in a large online sample. The moment-to-moment relationships between these factors in everyday life were then explored within a smaller sample, combining objective and self-report assessment methods.

7.2 Research Aim 1: Test the Relationship between Circadian and Social Rhythm Instability and Mood.

7.2.1 Hypothesis 1(A): The severity of mood states in the bipolar sample will be positively associated with the degree of circadian and social rhythm instability.

In line with current multilevel cognitive models of circadian instability (Jones, 2001), it was hypothesised that increases in rhythm instability would be associated with increases in the severity of mood states and mood symptoms in bipolar disorder. Therefore, in Study 1, positive correlations were anticipated between levels of sleep disturbance and symptom severity, with negative correlations anticipated between social rhythm regularity and symptom severity. In support of this hypothesis, subjective well-being was positively associated with

the number of regular activities performed over the previous month, and negatively correlated with subjective sleep disturbance. However, neither social rhythm regularity nor sleep disturbance significantly correlated with levels of activation, depression or anxiety.

In Study 2 it was expected that higher levels of rhythm instability over the study week, assessed using actigraphy and the social rhythm metric (SRM; Monk, Flaherty, Frank et al., 1990), would correlate positively with momentary levels of positive and negative affect recorded in the experience sampling diary. However, neither the intensity, nor variability, of momentary positive and negative affect across the study week, was associated with measures of rhythm instability.

In Study 1, mood states were assessed using the internal states scale (ISS; Bauer, Crits-Christoph, Ball et al., 1991) which measures the severity of bipolar-relevant mood symptoms over the past 24 hours. This contrasts with the assessment of mood in Study 2, whereby participants rated their mood “in the moment” at multiple points throughout each day. As significant relationships between rhythm instability and mood were only obtained in Study 1, this may indicate a distinction in the relationship between rhythm instability and daily versus momentary mood states. Indeed, mood ratings given “in the moment” have been found to correlate poorly with daily assessments (Hedges, Jandorf & Stone, 1985), indicating that the two forms of measurement represent different aspects of mood.

In Study 1, trait sleep disturbance and social rhythm regularity were assessed retrospectively using the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds III, Monk et al., 1989) and the trait version of the Social Rhythm Metric (SRM-T; Shen, Alloy, Abramson & Sylvia, 2008). In Study 2, rhythm instability was assessed at the state level using a combination of actigraphy, sleep diaries and the state SRM. Therefore it is possible that the different results obtained in each study represent differences in state versus trait rhythm instability in bipolar disorder. However, this interpretation conflicts with the finding that mood states were also not significantly associated with state-like sleep diary estimates of

sleep in Study 2. Available evidence concerning relationships between state and trait social rhythm regularity, also does not support this assumption. For example, Grandin, Hafner, Gauger et al. (2006) observed significant positive correlations between trait and state scores on the SRM in individuals with bipolar disorder and non-clinical controls, reporting that trait SRM scores significantly predicted state SRM scores four months later.

Only two other studies have reported findings regarding the association between actigraphically measured sleep duration and mood in euthymic bipolar disorder (Gershon, Thompson, Eidelman et al., 2012; Jones, Hare & Evershed, 2005), both reporting non-significant relationships similar to the current investigation. However, several studies have observed significant associations between mood and self-reported sleep duration in euthymic bipolar populations (Bauer, Grof, Rasgon, Bschor et al., 2006; Gruber, Miklowitz, Harvey et al., 2011; Kaplan, Gruber, Eidelman et al., 2011). When viewed together with the results obtained in Study 1, this suggests that mood states in euthymic bipolar individuals may be significantly related to self-reported, but not actigraphic, indices of sleep disturbance. The potential clinical implications of this are outlined in section 7.6.

7.2.2 Hypothesis 1(B): Non-clinical controls will demonstrate better circadian and social rhythm stability and less severe mood states than individuals with a diagnosis of bipolar disorder, individuals with a diagnosis of fibromyalgia, or individuals deemed to be at behavioural high-risk for bipolar disorder.

In accordance with existing evidence regarding the association between circadian instability and mood in euthymic bipolar populations (Bauer et al., 2006; Gruber et al., 2011; Kaplan et al., 2011), behavioural high-risk samples (Ankers & Jones, 2009), and fibromyalgia (Hamilton, Affleck, Tennen et al., 2008), it was anticipated that non-clinical control participants would exhibit lower levels of rhythm and mood disturbance compared to the other study groups. This hypothesis was partially supported in Study 1, with non-clinical

control participants scoring significantly lower on the PSQI in comparison to the other three study groups. However, significant differences in trait social rhythm regularity were not observed between the four groups.

In Study 2, non-clinical controls exhibited better sleep efficiency and subjective sleep quality in comparison to bipolar and fibromyalgia participants. However, group differences on other measures of sleep disturbance, state SRM score, and activity rhythm variables, were not statistically significant.

Whilst the non-significant differences in actigraphically-measured sleep duration and sleep onset latency between the bipolar and non-clinical control participants are consistent with the literature (Gershon et al., 2012; Harvey, Schmidt, Scarnà et al., 2005; Jones et al., 2005; Millar, Espie & Scott, 2004; St-Amand, Provencher, Bélanger & Morin, 2013), previous studies have not observed similar group differences in sleep efficiency (Gershon et al., 2012; Jones et al., 2005; Millar et al., 2004; Ritter, Marx, Lewtschenko et al., 2012; St-Amand et al., 2013). As mentioned previously (see Chapter 6), the bipolar participants studied in Study 2 exhibited much greater actigraphically-measured sleep disturbance than the bipolar samples studied in previous investigations, which may account for the conflicting results.

The lack of significant differences in activity rhythm amplitudes observed between the non-clinical control participants and the other study groups, corroborates findings of earlier studies (Jones et al., 2005; Salvatore, Ghidini, Zita et al., 2008), suggesting that disturbances in activity rhythms are not strongly implicated in chronic conditions. However, a new approach to the study of activity rhythm amplitudes using the ‘vulnerability index’, as described in Chapter 2, has indicated significantly higher rhythm amplitudes in non-clinical controls as opposed to euthymic bipolar individuals (Indic, Salvatore, Maggini et al., 2011). Currently, research concerning group differences in activity rhythms between non-clinical controls and populations at varying vulnerability for bipolar disorder is severely lacking. It will therefore be important for future studies to investigate group differences in activity

rhythm amplitudes when measured at different scales, to clarify the current state of the evidence.

The combined results of Study 1 and 4 indicate that subjective and objective sleep quality is significantly higher in non-clinical control populations compared to clinical and high-risk bipolar populations at both the state and trait level. These findings corroborate those reported by Harvey et al. (2005), and further indicate that psychological interventions should target the subjective experience of sleep as well as quantitatively-measured sleep disturbance. The findings suggest that such an intervention would benefit not only euthymic bipolar individuals, but also those considered at behavioural high-risk and individuals with fibromyalgia.

Overall, the results of the two studies suggest that social rhythm regularity does not differ significantly between clinical and non-clinical groups. Current evidence regarding differences in social rhythm regularity between bipolar and non-clinical control populations is mixed, although adequately-powered studies tend to report significantly lower levels of social rhythm regularity in bipolar populations (see Chapter 2). Due to concerns regarding the ability of both studies to detect statistically significant group differences in trait and state social rhythm regularity, further research investigating differences in social rhythms between individuals with and without bipolar disorder will be required using adequately powered samples.

In Study 1, non-clinical controls only differed significantly from the other three groups regarding levels of depression and anxiety, demonstrating significantly lower levels of both. Non-clinical controls exhibited similar levels of activation to fibromyalgia participants, and similar levels of well-being to the high-risk participants. These results suggest that negative, rather than positive, mood symptoms differentiate non-clinical controls from clinical and behavioural high-risk populations. In Study 2, non-clinical controls demonstrated significantly lower levels of negative affect intensity, and variability, compared to the fibromyalgia and

bipolar participants. However, contrary to hypothesised effects, the non-clinical controls also demonstrated greater intensity of positive affect compared to the bipolar participants, suggesting that high levels of general negative affect, and low levels of general positive affect, are characteristic of euthymic bipolar disorder and fibromyalgia.

Overall, the combined results indicate significantly elevated negative mood states in clinical populations and those at behavioural high-risk for bipolar disorder, compared to non-clinical controls. These findings corroborate existing evidence of higher negative mood states in euthymic bipolar populations (Gruber, Kogan, Mennin & Murray, 2013; Van der Gucht, Morriss, Lancaster et al., 2009), fibromyalgia populations (van Middendorp, Lumley, Jacobs et al., 2008), and individuals at behavioural and familial high-risk of bipolar disorder (Hoffman & Meyer, 2006; Jones, Tai, Evershed et al., 2006b) in comparison to non-clinical controls.

7.3 Research Aim 2: Test the Relationship between Internal Appraisal Style and Mood.

7.3.1 Hypothesis 2(A): The intensity of internal appraisal styles will positively correlate with the intensity of bipolar-relevant mood states in the bipolar sample.

Based upon the proposed causal relationship between internal appraisal styles and mood states in bipolar disorder (Jones, 2001; Mansell, Morrison, Reid et al., 2007), significant positive correlations were hypothesised between the tendency to internally appraise experiences, and the intensity of positive and negative moods in bipolar participants. The results obtained in Study 1 indicated that negative, internal appraisal styles, as assessed by the internal appraisal subscale of the Interpretations of Depression Questionnaire (IDQ-D; Jones & Day, 2008), were positively associated with levels of depression and anxiety, and negatively related to levels of well-being in the bipolar sample. However, positive, internal appraisal styles, assessed by scores on the internal appraisal subscale of the Hypomanic

Interpretations Questionnaire (HIQ-H; Jones, Mansell & Waller, 2006a), did not significantly correlate with any of the mood measures.

In Study 2, significant momentary relationships were observed regarding internal appraisal styles and the intensity of affective states across the study week. Positive, internal appraisal styles corresponded to increases in positive affect and decreases in negative affect, with negative internal appraisal styles demonstrating effects in the opposite direction. Internal appraisal styles were also significantly associated with momentary mood variability, such that stronger tendencies to form negative internal appraisals related to increased variability of both positive and negative affect. Positive, internal appraisals on the other hand, corresponded to reduced variability in negative, but not positive, affect.

Overall, the findings support the idea that internal appraisal styles are strongly related to affective states in bipolar disorder (Jones, 2001; Mansell et al., 2007). However, negative, internal appraisal styles were more consistently related to mood states at the state and trait level than positive, internal appraisal styles. In light of the predominantly low mood of the bipolar participants, these findings offer tentative support to the notion that internal appraisal styles may reflect ‘state-modulated trait-variables’ (Clark & Goodwin, 2004), such that positive internal appraisal styles are exacerbated by positive mood states and negative internal appraisal styles are exacerbated by negative mood states. In other words, the relationship between internal appraisal styles and mood in bipolar disorder may be bi-directional. Recommendations for future research in this area are outlined in section 7.7.

7.3.2 Hypothesis 2(B): Individuals with a diagnosis of bipolar disorder will demonstrate a stronger tendency to form internal appraisals of experiences than the other study groups.

In line with multilevel cognitive models (Jones, 2001; Mansell et al., 2007), it was anticipated that individuals with bipolar disorder would exhibit a stronger tendency to appraise experiences internally compared to the other study groups. In support of this

hypothesis, bipolar participants demonstrated significantly higher scores on the IDQ-D compared to non-clinical controls, individuals at behavioural high-risk, and individuals with fibromyalgia in Study 1. With regard to positive, internal appraisal styles, bipolar participants only demonstrated significantly higher scores on the HIQ-H compared to the non-clinical control and fibromyalgia participants, with individuals at behavioural high-risk exhibiting similar scores to the bipolar group. These findings suggest that both positive and negative, internal appraisal styles are implicated in bipolar disorder. However it is not clear from the current research to what extent negative internal appraisal styles represent vulnerability for bipolar disorder, or develop as a consequence of the condition (e.g. repeated negative experiences of mood episodes may reinforce a pessimistic cognitive style). To investigate this more fully, naturalistic, longitudinal studies of behavioural high-risk populations will be required to assess appraisal styles in individuals who do, and those who do not, go on to develop bipolar disorder.

In Study 2, bipolar participants demonstrated higher scores on the IDQ-D experience sampling item over the study week, compared to fibromyalgia and non-clinical control participants. However, group differences in momentary positive, internal appraisals were not statistically significant, with a trend for higher scores in the fibromyalgia group compared to the bipolar and non-clinical control groups. It is possible that the higher tendency to adopt positive internal appraisal styles in the fibromyalgia participants in Study 2, reflects the limitation of using single items to assess global psychological traits (i.e., whilst fibromyalgia participants indicated a trend towards stronger positive, internal appraisals of feeling restless and full of energy compared to the bipolar and non-clinical control participants, it is not clear how the participants would have compared regarding positive, internal appraisals for other experiences listed in the HIQ). Therefore, it is recommended that future studies use adapted ESM measures of appraisal style alongside comprehensive, validated measures to assess the degree of correlation between scores obtained from the two different methods.

It is noteworthy that the bipolar participants demonstrated a strong tendency to form both negative and positive internal appraisals at the trait level, but only demonstrated tendencies to form negative internal appraisals at the state level. This may reflect differences in the participants' perceived cognitive styles when assessed at the trait level, compared to how they appraise experiences at the state level, in a real life setting. This idea is supported by evidence regarding attributional styles in bipolar populations when assessed explicitly versus implicitly (see Chapter 3). Alternatively, the pattern of findings may reflect instability in positive, internal appraisal styles i.e., whilst the bipolar participants did not differ significantly from the other groups regarding the tendency to form state-like positive internal appraisals over the study week, the stability of these appraisal styles may be much lower. As instability in bipolar disorder has been documented in a number of domains (Henry, Mitropoulou, New et al., 2001; Hoffman & Meyer, 2006; Knowles, Tai, Jones et al., 2007), exploration of the stability of appraisal styles is warranted.

7.3.3 Hypothesis 2(C): The relationship between circadian and social rhythm instability and mood in bipolar disorder will be weaker without the added influence of internal appraisal style.

In line with Jones' (2001) account of bipolar disorder, it was predicted that internal appraisal styles would demonstrate a moderating effect upon the relationship between rhythm instability and mood in bipolar disorder, such that a tendency to internally appraise experiences would intensify the impact of rhythm instability upon mood states. In Study 1, this hypothesis was tested using multiple regression analyses to assess interactions between scores on the HIQ-H and IDQ-D, and scores on the measures of rhythm instability. Due to the multilevel nature of the ESM data obtained in Study 2, the moderating effect of momentary internal appraisals upon rhythm instability was assessed using multilevel regression models.

In both studies, the results of the regression analyses did not indicate a statistically significant moderation effect. However, as non-significant moderation effects were observed in the expected direction, it is possible that the findings reflect inadequate statistical power in both cases. The size of the regression coefficients obtained also indicates that the moderating effect of internal appraisal style may represent a small effect, and therefore larger sample sizes may be required to detect statistically significant relationships.

The small effects sizes also suggest that other factors may moderate the relationship between rhythm instability and mood in bipolar disorder. Numerous psychological factors have been associated with mood change in bipolar disorder, such as coping styles (Christensen & Kessing, 2005; Jones et al., 2006b), personality traits (Barnett, Huang, Perlis et al., 2011; Quilty, Pelletier, DeYoung & Bagby, 2013), and social support (Eidelman, Gershon, Kaplan et al., 2012; Johnson, Winett, Meyer et al., 1999). However, research into how these factors may interact with circadian and social rhythm instability in bipolar disorder is almost non-existent. This is disappointing given the various ways in which psychological and circadian factors may relate. Consider the example of an individual with bipolar disorder who has recently moved house to a noisy area, disrupting their sleep patterns. This disruption may then cause physiological feelings of tiredness and fatigue. It is then likely that numerous factors will interact in the interpretation of this feeling. For example, the individual may recognise feeling tired as a warning sign for depression, depending on their ability to identify such warning signs and the number of previous episodes which they have experienced. Perceived levels of social support may also influence this interpretation, with individuals who possess high levels of perceived social support feeling more confident in their ability to manage the feelings of fatigue and prevent the onset of depressive symptoms, than someone with low levels of perceived social support. It is likely that levels of self-esteem and coping style will also interact in this process, influencing the degree of mood change triggered by the initial disruption to sleeping patterns (see Figure 1).

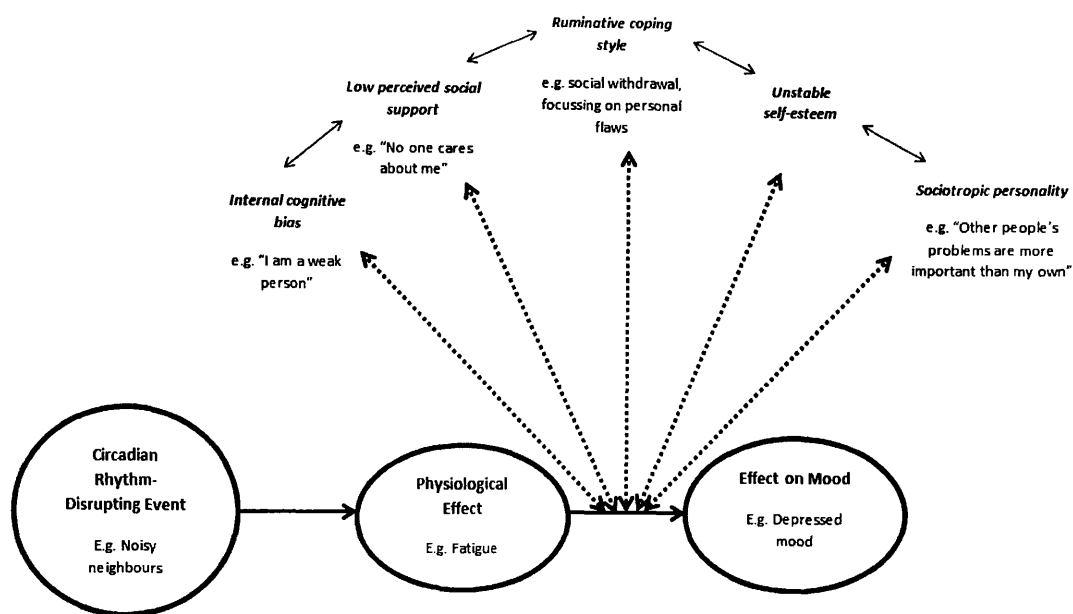


Figure 1. Illustrative example of possible moderating factors.

Clearly much more research is required in this area to shed light on the potential interactions that may exist between these factors. A deeper understanding of the underlying processes which influence the relationship between rhythm disruption and mood change in bipolar disorder, would have important implications for theory and practice.

7.4 Research Aim 3: Explore the Variability of Circadian Rhythms and Mood in Bipolar Disorder.

As circadian rhythms and mood states were assessed at multiple time points in Study 2, this allowed for exploration of how these factors fluctuate over time during an average week. No statistically significant group differences in the variability of sleep patterns based on self-reported or actigraphically obtained data were observed, suggesting that sleep pattern

variability may not play a unique role in chronic conditions such as bipolar disorder and fibromyalgia.

Measures of activity variability both within (intradaily variability; IV) and between (interdaily stability; IS) days, did not differ significantly between the three groups which suggests that variability in activity rhythms is not significantly implicated in bipolar disorder. However, these findings contradict the results reported by Jones et al. (2005) who observed significantly higher IV and lower IS in euthymic bipolar individuals as compared to non-clinical controls. Due to the lack of research concerning activity rhythm variability in bipolar populations, interpretation of the findings is challenging. However, as described previously (see Chapter 6), a higher proportion of the bipolar sample studied by Jones et al. (2005) reported taking mood-stabilising medication compared to the bipolar sample studied in the present investigation. As research suggests that mood stabilisers can significantly distort circadian rhythms (Klemfuss, 1992), it is possible that differences in the use of mood-stabilising medication between the two studies, underlie the conflicting results. To explore this hypothesis fully, further studies are required which control for the potentially confounding effects of medication upon physical activity in bipolar and non-clinical control populations.

In Study 2, no statistically significant differences were observed in positive affect variability from moment-to-moment between the three groups. However, bipolar participants demonstrated greater variability in levels of negative affect compared to both the fibromyalgia, and non-clinical control, participants. These findings complement those reported by Bentall, Myin-Germeys, Smith et al. (2011), who observed significantly higher levels of negative, but not positive, affect variability in individuals at behavioural high-risk for bipolar disorder compared to non-clinical controls. The results of the present research therefore add to the available evidence suggesting that variability of negative, but not positive, affect may be uniquely implicated in bipolar disorder (Lovejoy & Steuerwald, 1995; Meyer & Hofmann, 2005).

7.5 Summary of Findings and Theoretical Implications

Viewed together, the results of the two studies indicate that both subjective and objective sleep disturbance are strongly implicated in bipolar disorder and fibromyalgia, adding further support to the argument that sleep disturbance may represent a transdiagnostic process (Harvey, 2008a; 2008b; 2009; Harvey, Murray, Chandler & Soehner, 2011). These findings also provide further evidence to the instability model of bipolar disorder (Goodwin & Jamison, 1990), upon which Jones' (2001) adapted SPAARS model is heavily based.

A strong tendency to adopt negative, internal appraisal styles was observed at both the state and trait level in euthymic bipolar participants, whilst the tendency to form positive internal appraisals was only detected at the trait level. Additionally, negative internal appraisal styles were significantly related to mood states at both the state and trait level, whereas positive internal appraisal styles were only associated with mood at the state level. These findings offer support to multilevel cognitive models which emphasize the importance of internal cognitions in the course of bipolar mood change (Jones, 2001; Mansell et al., 2007), and also indicate that negative internal appraisal styles may be more pervasive than positive internal appraisal styles in bipolar disorder (Kelly, Mansell, Wood et al., 2011). This implies that current multilevel cognitive models of bipolar disorder may require further development to account for differences in the relationship between appraisal style and mood at the state and trait level.

Whilst self-reported trait-like disturbances in sleep and social rhythm regularity were negatively associated with positive mood, significant associations between state-like rhythm instability and mood were not observed. In light of the contradictory nature of existing evidence in this area, further research is required to explore potential differences in the relationship between rhythm instability and mood in bipolar disorder when assessed using objective versus self-report methods at the state versus trait level. This will be crucial in informing models of bipolar disorder which emphasize the importance of rhythm instability in

bipolar mood change (Ehlers, Frank & Kupfer, 1988; Goodwin & Jamison, 2009; Harvey, 2008a; Jones, 2001).

The results of the current research indicate that internal appraisal styles do not strengthen the relationship between rhythm instability and mood in euthymic bipolar disorder. Whilst this casts doubt upon the validity of multilevel cognitive models (Jones, 2005; Mansell et al., 2007), the significant associations between internal appraisal style and mood observed in the current study indicate that appraisal styles may be state-modulated. In other words, internal appraisal styles may exert stronger effects upon the relationship between rhythm instability and mood, as mood intensity increases. This could account for the non-significant findings observed in the current research, and highlights the need to explore the moderating effect of internal appraisals during extreme mood states. It is also possible that the influence of internal appraisal styles represents a small effect due to the influence of other potential moderating factors (see Figure 1). Further examination of these issues is therefore required to inform and improve current models.

7.6 Clinical Implications

A number of important clinical implications may be drawn from the findings of the current research. For example, the finding that subjectively measured sleep disturbance demonstrated stronger associations with mood than objectively measured sleep disturbance, combined with existing evidence that euthymic bipolar individuals overestimate the degree to which their sleep is disturbed (Harvey et al., 2005), indicates potentially important clinical implications. Psychotherapeutic interventions which focus on improving the subjective experience of sleep, including targeting maladaptive sleep beliefs, may be more effective in preventing mood escalation than interventions which focus solely on improving quantitatively-measured sleep disturbance. The potential benefits of a cognitive sleep intervention for mood-disordered individuals, has been intimated previously (Harvey, 2008a;

2011; Harvey et al., 2005). This has triggered an upsurge in studies investigating the efficacy of cognitive behavioural therapy for insomnia (CBT-I) in a variety of chronic illness populations (Dirksen & Epstein, 2008; Jungquist, O'Brien, Matteson-Rusby et al., 2010; Smith, Huang & Manber, 2005).

A study investigating the benefits of an abbreviated programme of (CBT-I) for psychiatric outpatients (Wagley, Rybarczyk, Nay et al., 2013), reported significant improvements in subjective sleep quality and symptoms of depression. Furthermore, 38% of the sample assigned to the intervention achieved “normal” sleep within eight weeks post-treatment, in comparison to none of the individuals who received treatment as usual (Wagley et al., 2013). However, of those who received the CBT-I intervention (n=20) only 3 had a diagnosis of bipolar disorder.

A recent pilot study assessing the efficacy of a brief sleep intervention specifically for individuals with bipolar disorder, reported increases in sleep duration and reduced daytime dysfunction following the intervention (Sylvia, Salcedo, Bianchi et al., 2014). Although changes in mood symptoms were not statistically significant, a trend towards improvement in manic and depressive symptomatology was observed. Conversely, participants exhibited greater instability in their sleep patterns post-treatment, and did not show any improvement in subjective sleep quality (Sylvia et al., 2014). However, due to the small size of the sample (n=8), further research examining the efficacy of cognitive sleep interventions for bipolar disorder on a larger scale is required. Studies are currently taking place to address this issue, with results expected in 2015 (Steinan, Krane-Gartiser, Langsrud et al., 2014).

As the bipolar and fibromyalgia participants demonstrated significantly greater objective and subjective sleep disturbance compared to non-clinical controls, this suggests that such disturbances may be transdiagnostic across similarly chronic conditions (Harvey, 2009). The identification of sleep disturbance as a transdiagnostic process could have important implications for our understanding of risk factors associated with the future

development of specific conditions (Scott, Leboyer, Hickie et al., 2013), and may also lead to the development of more effective interventions as indicated by the Research Domain Criteria initiative (Fairholme, Nosen, Nillini et al., 2013; Sanislow, Pine, Quinn et al., 2010). It is therefore recommended that future studies seek to assess the degree to which sleep disturbance is transdiagnostic across various mental and physical health conditions.

The current research also highlights that euthymic bipolar individuals and individuals with fibromyalgia, are consciously aware of the degree to which their sleep is disturbed, suggesting that individuals from both populations would be open to interventions which aim to improve sleep quality. The direction of the relationship between beliefs about sleep and objective sleep disturbance in chronic conditions, it not currently clear from the available literature. It is possible that the belief that one's sleep is very disturbed, originates from a significant and prolonged sleep disturbance. Additionally, a significant and prolonged sleep disturbance may be exacerbated by negative beliefs about sleep, creating a bi-directional feedback loop (Harvey, 2002; Harvey et al., 2005). It will be important for future studies to attempt to uncover the nature of this relationship to maximise the efficacy of sleep interventions such as CBT-I.

Although the results of Study 2 indicate variability in circadian rhythms and mood both within and between days over an average week, changes in the degree of variability within these variables in the longer term is unknown. For example, over an average week an individual may exhibit high social rhythm regularity, sleep pattern stability and interdaily stability. However, the apparent stability of these rhythms may change significantly over weeks, months, even years. This could have important treatment implications, as individuals may require support in maintaining regular rhythms at some points but not others, requiring a flexible clinical approach. Due to the episodic nature of bipolar mood states, it is likely that many individuals are able to cope with minor rhythm disturbances, but struggle with more major events for which clinical support may be particularly effective in preventing relapse. It is therefore recommended that future studies assessing circadian and social rhythm stability,

include long-term follow-up periods to explore changes in the degree of variability and intensity of rhythm disturbances over time in bipolar populations.

Overall, the results of the present research indicate that trait and state-like internal, negative appraisal styles are associated with the intensity and variability of mood states in bipolar disorder. This holds important clinical implications, suggesting that cognitive therapies which target negative, internal appraisals may be particularly beneficial for euthymic individuals with bipolar disorder in terms of promoting affective stability and reducing the intensity of positive and negative moods day-to-day.

7.7 Limitations and Directions for Future Research

In both studies, internal appraisal styles did not significantly moderate the relationship between rhythm instability and mood in the bipolar samples, contradicting multilevel cognitive models of bipolar disorder. However, in both studies, appraisal styles were assessed using items from the HIQ and IDQ (in full in Study 1 and with two items in Study 2). Whilst these measures aim to capture appraisal styles relevant to euthymic individuals with bipolar disorder, how euthymic bipolar individuals appraise rhythm-disrupting experiences in reality is unknown. In other words, it is unclear how relevant the two internal/external appraisal subscales offered by the HIQ and IDQ really are to euthymic bipolar individuals, particularly as the subscales were developed with reference to a questionnaire designed to assess appraisals for somatic symptoms (Robbins & Kirmayer, 1991), which may be appraised differently to bipolar-relevant experiences. For example, it may be that euthymic bipolar individuals are unable to attribute a change in state to an internal or external cause, and that being unable to interpret an experience (e.g. “I don’t know why I feel sped up inside”) has a more significant impact on mood due to the associated sense of not being in control. Therefore current understandings of the nature of appraisals in bipolar disorder may be

informed by naturalistic studies which assess appraisals of rhythm-disrupting events as they occur, using qualitative interviewing methods.

As significant findings were obtained regarding the variability of positive and negative affect between groups, and also within the bipolar sample, future studies should investigate the variability of internal appraisal styles within these populations. Studies investigating the role of self-esteem in bipolar disorder, indicate that clinical bipolar individuals and those at behavioural high-risk, demonstrate significantly higher levels of self-esteem variability in comparison to non-clinical controls (Bentall et al., 2011; Knowles, Tai, Jones et al., 2007; Van der Gucht et al., 2009), suggesting that such variability is strongly implicated throughout the course of the disorder. It is therefore possible that the variability of internal appraisal styles also plays an important role, and may be more strongly associated with the variability of affective states and circadian rhythms, than the intensity of such cognitions.

Overall, the present research does not lend support to the assumption that circadian rhythm instability in bipolar disorder is preceded by disruptions to social rhythms, as implied by the social zeitgeber hypothesis (Ehlers, Frank & Kupfer, 1988). However, this may be because longitudinal relationships between circadian and social rhythms were not assessed. Whilst the results obtained in the current research suggest that social rhythm regularity does not play an important role in bipolar disorder, it is possible that euthymic bipolar individuals do not necessarily demonstrate higher levels of social rhythm instability, as indicated by state and trait SRM scores, but are more sensitive to disturbances in these rhythms compared to non-clinical controls. Longitudinal studies which assess changes in social rhythm regularity in response to disrupting events across clinical and non-clinical populations, will be necessary to explore this issue fully.

In the present research, the potential effects of current mood upon appraisal style were not controlled for. As the findings offer tentative support for the role of negative internal appraisal styles as state-modulated trait variables in euthymic bipolar disorder, it will be

important for future studies to address this more directly. There are various ways in which the state-modulated trait theory could be assessed, from mood induction studies which assess appraisal during neutral, positive and negative moods, to conducting naturalistic, longitudinal assessments of appraisal styles during which time clinical mood states will fluctuate naturally.

As mentioned previously, the potential effects of psychotropic medications were not controlled for in either study, therefore it is not clear to what extent observed differences between the groups reflect true differences between the populations, or reflect the effects of mood-stabilising and sedating medications. Previous studies have reported significant effects of mood-stabilising medication upon sleep and activity rhythms, emotional processing and coping styles within bipolar populations (Baune, Caliskan & Todder, 2006; Boudebessé & Henry, 2012; Fletcher, Parker & Manicavasagar, 2013; Joffe, Uhde, Post & Minichiello et al., 1987; Kupfer, Weiss, Foster et al., 1974). However, Kaplan and colleagues (2012) did not observe significant relationships between medication class and actigraphic, sleep diary or PSG estimates of sleep in their euthymic bipolar sample. Further research exploring the effects of psychotropic medication upon circadian rhythms, cognitive processing, and mood states in bipolar disorder, will therefore be important in disentangling the state of the current evidence.

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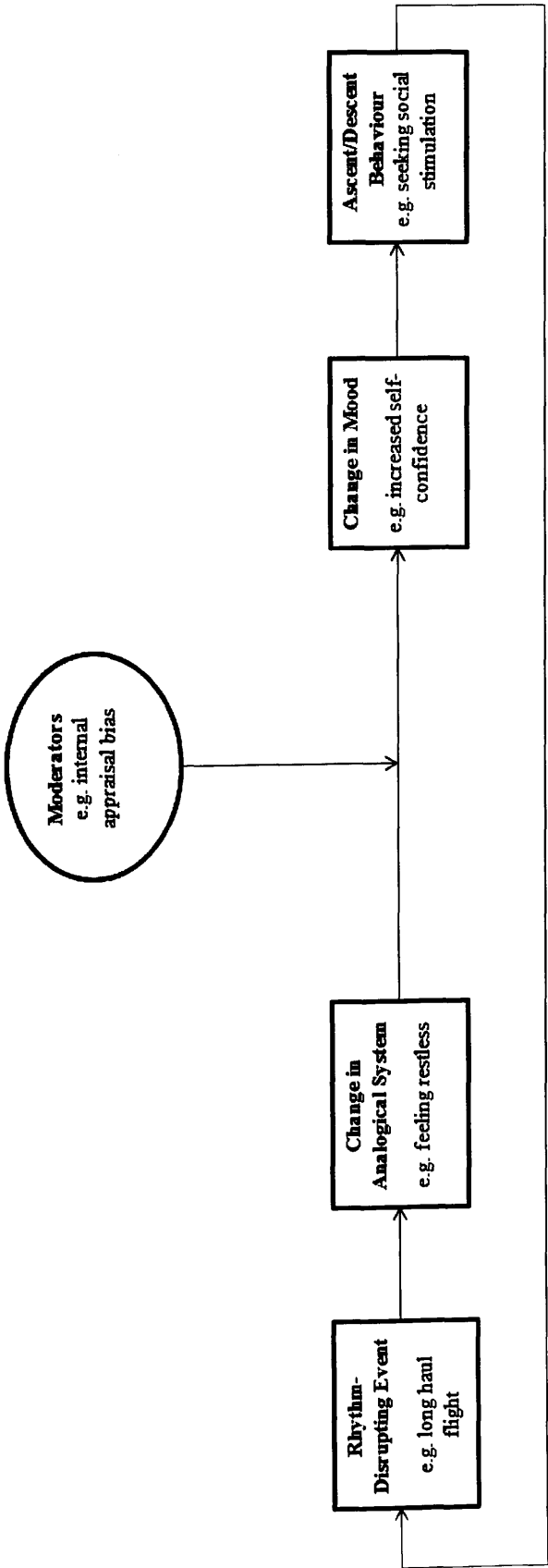
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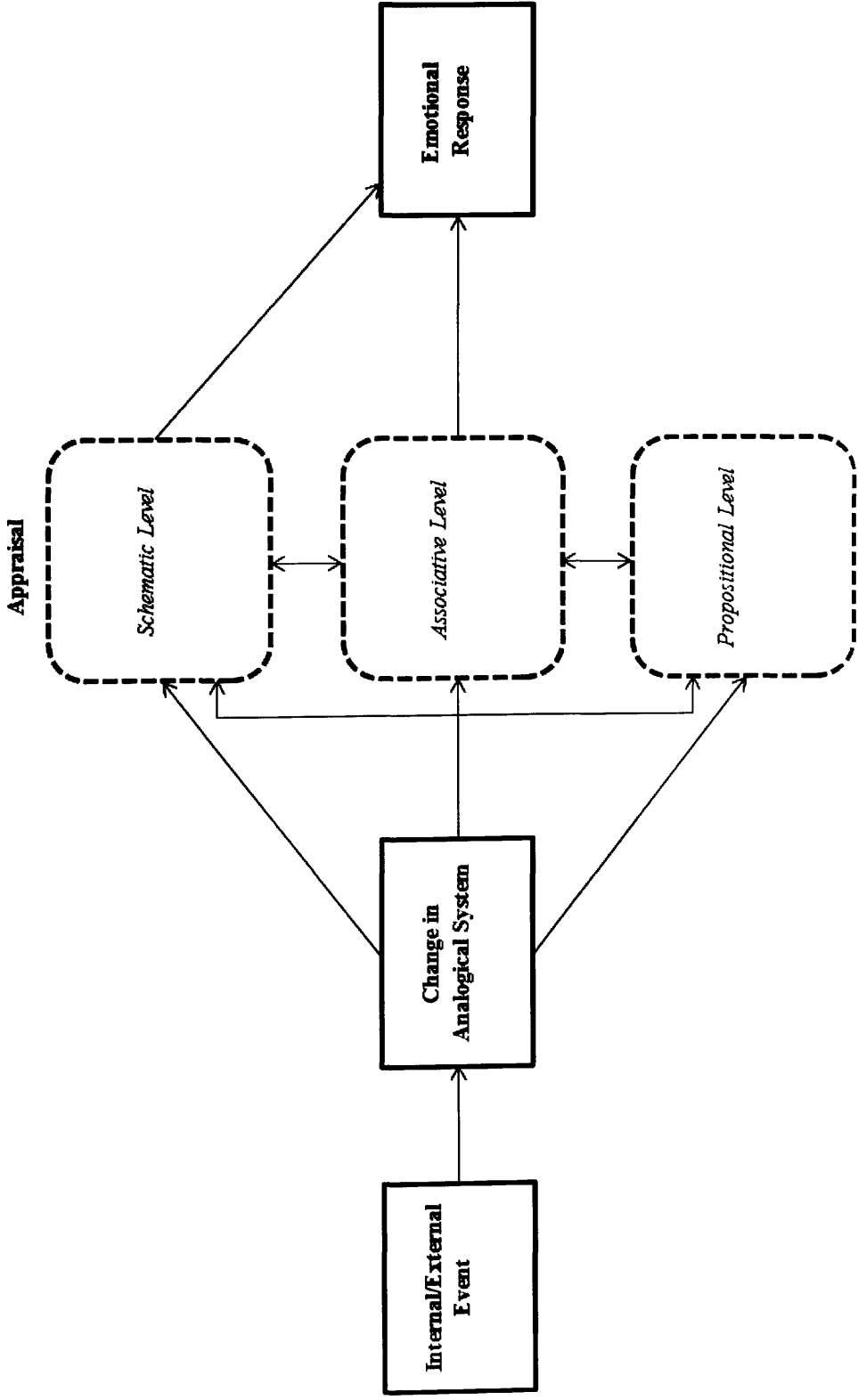
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Appendix 1: Jones' (2001) adapted SPAARS model



Appendix 2: The SPAARS model (Power & Dalgleish, 1997)



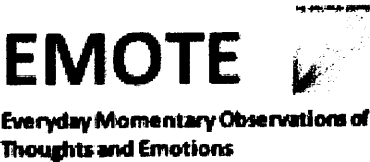
Appendix 3: The ESM Diary

Please note:

- The actual size of the dairy used in the study was A5.
- Pages 4 to 6 were repeated ten times within each dairy.

PANO:

1



Day

PANO:

2

EXPERIENCE SAMPLING BOOKLET

IMPORTANT REMARKS ABOUT THE BOOKLET:

- Fill in the booklet immediately after you've received a text message from the research team prompting you to do so.
- Don't think too long about the questions. We are interested in your spontaneous responses. Circle one digit on every line.
- Don't forget to fill in the last page of the booklet before you go to sleep!

IMPORTANT REMARKS ABOUT THE EQUIPMENT:

The actiwatch is semi-water resistant, meaning you may wear it in the shower for up to 30 minutes but no longer. Please do not swim or bathe with the watch on.

Text messages will be sent to your mobile phone or to a phone provided to you by the research team asking you to fill in the diary. This will happen 10 times a day, at random times between 08:00AM and 10:00PM.

If you did not receive any text messages from the research team during the day for four hours, there is possibly something wrong with the text message schedule we have set up for you. Please let us know!

Subject number: | | | | |

Actiwatch Number Participant Number

Day number: | | | | |

Diary Date: Start End

Time series: | | | | |

Booklet code

Codebook

PANO:

3

GOOD MORNING!

Day _____ Date: _____ / _____ / _____

Please answer the following questions relating to your sleep and activity patterns:

Bedtime (what time did you go to bed last night?): _____

Estimated sleep time (what time do you think you fell asleep?): _____

Wake up time (what time do you think you became awake this morning?): _____

Get up time (what time did you get up this morning?): _____

How well did you sleep last night?
well

Not well at all

Very

1 2 3 4 5 6 7 8 9 10

PAND:

4

A	What was I thinking (just before the text alert went off)? <hr/> <hr/>																																																																																																													
B	<table style="width: 100%; border-collapse: collapse;"> <tr> <th></th> <th colspan="3">Not</th> <th colspan="3">Moderate</th> <th colspan="3">Very</th> </tr> <tr> <td>Right now I have trouble concentrating</td> <td>1</td><td>2</td><td>3</td> <td>4</td><td>5</td><td>6</td> <td>7</td><td></td><td></td> </tr> </table>											Not			Moderate			Very			Right now I have trouble concentrating	1	2	3	4	5	6	7																																																																																		
	Not			Moderate			Very																																																																																																							
Right now I have trouble concentrating	1	2	3	4	5	6	7																																																																																																							
C	Please describe your mood just before the text alert went off: <table style="width: 100%; border-collapse: collapse;"> <tr> <th>I feel...</th> <th colspan="3">Not</th> <th colspan="3">Moderate</th> <th colspan="3">Very</th> </tr> <tr> <td>• cheerful</td> <td>1</td><td>2</td><td>3</td> <td>4</td><td>5</td><td>6</td> <td>7</td><td></td><td></td> </tr> <tr> <td>• energetic</td> <td>1</td><td>2</td><td>3</td> <td>4</td><td>5</td><td>6</td> <td>7</td><td></td><td></td> </tr> <tr> <td>• confident</td> <td>1</td><td>2</td><td>3</td> <td>4</td><td>5</td><td>6</td> <td>7</td><td></td><td></td> </tr> <tr> <td>• anxious</td> <td>1</td><td>2</td><td>3</td> <td>4</td><td>5</td><td>6</td> <td>7</td><td></td><td></td> </tr> <tr> <td>• relaxed</td> <td>1</td><td>2</td><td>3</td> <td>4</td><td>5</td><td>6</td> <td>7</td><td></td><td></td> </tr> <tr> <td>• worried</td> <td>1</td><td>2</td><td>3</td> <td>4</td><td>5</td><td>6</td> <td>7</td><td></td><td></td> </tr> <tr> <td>• bad about myself</td> <td>1</td><td>2</td><td>3</td> <td>4</td><td>5</td><td>6</td> <td>7</td><td></td><td></td> </tr> <tr> <td>• down</td> <td>1</td><td>2</td><td>3</td> <td>4</td><td>5</td><td>6</td> <td>7</td><td></td><td></td> </tr> <tr> <td>• guilty</td> <td>1</td><td>2</td><td>3</td> <td>4</td><td>5</td><td>6</td> <td>7</td><td></td><td></td> </tr> </table>										I feel...	Not			Moderate			Very			• cheerful	1	2	3	4	5	6	7			• energetic	1	2	3	4	5	6	7			• confident	1	2	3	4	5	6	7			• anxious	1	2	3	4	5	6	7			• relaxed	1	2	3	4	5	6	7			• worried	1	2	3	4	5	6	7			• bad about myself	1	2	3	4	5	6	7			• down	1	2	3	4	5	6	7			• guilty	1	2	3	4	5	6	7		
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• guilty	1	2	3	4	5	6	7																																																																																																							
D	<table style="width: 100%; border-collapse: collapse;"> <tr> <th></th> <th colspan="3">Not</th> <th colspan="3">Moderate</th> <th colspan="3">Very</th> </tr> <tr> <td>Overall, I'm feeling happy</td> <td>1</td><td>2</td><td>3</td> <td>4</td><td>5</td><td>6</td> <td>7</td><td></td><td></td> </tr> </table>											Not			Moderate			Very			Overall, I'm feeling happy	1	2	3	4	5	6	7																																																																																		
	Not			Moderate			Very																																																																																																							
Overall, I'm feeling happy	1	2	3	4	5	6	7																																																																																																							
E	<table style="width: 100%; border-collapse: collapse;"> <tr> <th>My current mood...</th> <th colspan="3">Negatively</th> <th colspan="4">Not affecting</th> <th colspan="3">Positively</th> </tr> <tr> <td>• is affecting me at the moment</td> <td>-4</td><td>-3</td><td>-2</td> <td>-1</td><td>0</td><td>1</td><td>2</td> <td>3</td><td>4</td><td></td> </tr> <tr> <td>My current mood...</td> <td colspan="9"></td> <td></td> </tr> <tr> <td>• is controllable by me</td> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> <tr> <td>• is causing me concern</td> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> <tr> <td>• makes sense to me</td> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> <tr> <td>• will continue for a long time</td> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> <tr> <td>• was caused by my own behaviour</td> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> </table>										My current mood...	Negatively			Not affecting				Positively			• is affecting me at the moment	-4	-3	-2	-1	0	1	2	3	4		My current mood...											• is controllable by me	1	2	3	4	5	6	7	8	9	10	• is causing me concern	1	2	3	4	5	6	7	8	9	10	• makes sense to me	1	2	3	4	5	6	7	8	9	10	• will continue for a long time	1	2	3	4	5	6	7	8	9	10	• was caused by my own behaviour	1	2	3	4	5	6	7	8	9	10												
My current mood...	Negatively			Not affecting				Positively																																																																																																						
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• was caused by my own behaviour	1	2	3	4	5	6	7	8	9	10																																																																																																				
F	I want to make my mood (please underline)... Go up / Go down / Stay the same I intend to make my mood go up / down / stay the same by (please state the main thing you intend to do) _____																																																																																																													

PAND:

5

G	Right now I am...	Not at all	Somewhat	Quite a bit	A great deal
	• In high spirits and full of energy	1	2	3	4
	I feel like this because...				
	• I am a talented person with lots to offer	1	2	3	4
	• Things happen to be going well for me at present	1	2	3	4

H	Right now I am...	Not at all	Somewhat	Quite a bit	A great deal
	• Feeling down on myself	1	2	3	4
	I feel like this because...				
	• I am a bad person, even towards myself	1	2	3	4
	• Current problems are leading me to be rather hard on myself	1	2	3	4

I	Where am I? (when you received the text alert)	_____						
	Who am I with? (State their relationship to you)	_____						
	In the company of these people, I feel:	Not			Moderate			Very
	• Comfortable	1	2	3	4	5	6	7
	• threatened	1	2	3	4	5	6	7

J	What am I doing (just before the text alert went off)?	_____

PAND:

6

K

Since the last text alert, have you done anything with the intention of modifying your mood (make your mood go up / go down / stay the same)? If so, what is the main thing you have done?

What impact has this had on your mood? (please underline)

Lifted my mood / Made my mood
go down / No impact

L

Since the last text alert, the most important significant event that happened to me was:

• This was:

very unpleasant 1 2 3 4 5 6 7 very pleasant

M

	Not		Moderate		Very		
This text alert irritated me	1	2	3	4	5	6	7

N

It is now exactly: ____ hrs ____ min

PAND:

7

Please answer the following questions just before you go to bed:

Please note down any events that occurred during today that disrupted your usual activity/routine (e.g. noise, pain, etc.):

-
-
-
-
-

Please note down any periods when you were not wearing the actiwatch:

From..... to..... Reason.....

From..... to..... Reason.....

From..... to..... Reason.....

From..... to..... Reason.....

From..... to..... Reason.....

I did not fill in the booklet...

From:..... hrs..... min to:..... hrs..... min Reason:.....

From:..... hrs..... min to:..... hrs..... min Reason:.....

From:..... hrs..... min to:..... hrs..... min Reason:.....

- | | Not | | | Moderate | | | Very |
|--|-----|---|---|----------|---|---|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| • It was an ordinary day | | | | | | | |
| • Filling in the booklet influenced my mood today | | | | | | | |
| • Without the watch I would have done other things today | | | | | | | |

The time now is exactly

GOOD NIGHT!!

Appendix 4: Study 1 Regression Models

Table 1. Regression estimates for social rhythm regularity, sleep disturbance, and internal appraisal style in relation to mood symptoms in the bipolar group.

Predictor Variable (95% CI)	REG	AVE	PSQI	HIQ-H	IDQ-D
Outcome Measure					
ISS-A	0.04 (-0.39 to 0.47)	-0.08 (-0.46 to 0.30)	-0.02 (-0.43 to 0.38)	0.14 (-0.26 to 0.54)	0.18 (-0.26 to 0.62)
ISS-WB	-0.09 (-0.47 to 0.30)	0.18 (-0.16 to 0.51)	-0.33 (-0.69 to 0.02)	0.36 (0.003 to 0.71)	-0.18 (-0.57 to 0.21)
ISS-D	0.24 (-0.23 to 0.70)	-0.06 (-0.47 to 0.35)	0.25 (-0.19 to 0.68)	-0.14 (-0.57 to 0.29)	0.47 (-0.004 to 0.95)
HADS-A	-0.02 (-0.46 to 0.42)	-0.17 (-0.55 to 0.21)	0.22 (-0.19 to 0.63)	0.02 (-0.39 to 0.44)	0.47 (0.02 to 0.93)

Note: None of the main effects were statistically significant at the $p < .01$ level.

Appendix 5: Study 1 Post-hoc Comparisons

Table 1. Post-hoc between-group comparisons and effect sizes for age, social rhythm regularity, sleep quality, internal appraisal styles, and mood.

Age		REG		PSQI		HIQ-H		IDQ-D		ISS-A		ISS-WB		ISS-D		HADS-A		
<i>t(df)</i>	<i>d</i>	<i>t(df)</i>	<i>d</i>	<i>t(df)</i>	<i>d</i>	<i>t(df)</i>	<i>d</i>	<i>t(df)</i>	<i>r</i>	<i>t(df)</i>	<i>r</i>	<i>t(df)</i>	<i>r</i>	<i>t(df)</i>	<i>r</i>	<i>t(df)</i>	<i>d</i>	
CON vs FM	-6.76(119.2)***	-.76	2.52(451)*	.31	-13.9(53.89)***	-2.36	12096.5(538)***	.18	14980.5(576)***	.15	12880.5(485)	.02	6079(485)***	.65	8398(485)***	.22	-5.21(476)***	-.71
CON vs BD	-3.19(547)**	-.48	1.67(431)	.25	-5.44(42.7)***	-1.02	4577.5(512)***	.30	4095.5(546)***	.34	5658(470)***	.23	6397.5(470)***	.19	5690(470)***	.24	-7.28(52.9)***	-1.20
CON vs HYP	5.12(113.1)***	.58	2.46(78.5)*	.35	-3.78(63.6)***	-.60	5958.5(531)***	.36	12405(573)***	.21	3635(489)***	.45	12572(489)	.07	11080.5(489)**	.14	-5.79(80.46)***	-.82
FM vs BD	1.48(129)	.26	-.32(98)	-.06	5.58(85)***	1.19	461.5(122)***	.63	972.5(128)***	.43	916.5(109)***	.34	1396(109)	.07	1338.5(109)	.10	-3.05(108)**	-.56
FM vs HYP	9.30(155)***	1.48	10(122)	.03	8.02(101)***	1.56	555.5(141)***	.68	2798.5(155)	.08	687.5(128)***	.58	844.5(128)***	.52	1777.5(128)	.14	-1.07(128)	-.17
BD vs HYP	6.38(126)***	1.14	4.2(102)	.09	1.79(92)	.37	1468(115)	.10	995.5(125)***	.41	1108(113)**	.26	922(113)***	.36	1183.5(113)*	.23	1.90(112)	.36

Note: CON= Non-clinical controls; FM= Fibromyalgia participants; BD= Bipolar participants; HYP= High-risk participants; HIQ-H= Internal appraisal subscale of Hypomanic Interpretations Questionnaire; IDQ-D= Internal appraisal subscale of Interpretations of Depression Questionnaire; REG= Number of regular activities performed over the past month; AVE= Average frequency with which regular activities were performed over the past month; PSQI= Pittsburgh Sleep Quality Index score; ISS-A= Activation subscale of Internal States Scale; ISS-WB= Well-being subscale of Internal States Scale; ISS-D= Depression subscale of Internal States Scale; HADS-A= Anxiety scale of Hamilton Anxiety and Depression Scale.

Post-hoc comparisons were computed using Student's t-test (or Mann-Whitney U where data demonstrated a non-normal distribution). Effect sizes were computed using Cohen's *d* (or *r* where data demonstrated a non-normal distribution).

p* < .05; *p* < .01; ****p* < .001.

Appendix 6: Study 2 SRM Imputation

Number of participants with missing SRM data for each item per day

Table 1. Bipolar Sample

		SRM Item															
Day		1	2	3	4	5	6	7	8	9	10	11	12	13	16	17	
1		0	0	0	0	0	0	0	0	1	0	0	2	1	0	2	
2		0	0	1	0	0	1	0	0	0	1	3	0	3	1	0	
3		0	0	0	0	0	0	0	0	0	1	1	2	0	1	0	
4		0	0	0	0	0	0	0	0	0	0	2	1	1	1	0	
5		0	0	0	0	0	0	0	0	0	0	0	2	1	0	3	
6		1	0	0	0	0	0	0	1	0	0	0	0	2	0	2	
7		0	0	0	0	0	0	0	1	0	2	1	0	1	2	3	

Table 2. Fibromyalgia Sample

SRM Item																	
Day		1	2	3	4	5	6	7	8	9	10	11	12	13	16	17	
1	1	1	0	0	1	0	1	0	0	0	1	2	1	1	0	0	
2	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	
3	0	0	0	0	0	0	0	0	0	0	2	1	1	1	0	0	
4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
5	0	0	0	0	0	0	0	2	0	1	0	1	0	1	0	0	
6	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	0	
7	0	0	1	0	1	1	1	0	0	0	1	0	0	3	0	0	

Table 3. Non-clinical Control Sample

		<i>SRM Item</i>															
	1	2	3	4	5	6	7	8	9	10	11	12	13	16	17		
Day																	
1	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0		
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2		
3	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0		
4	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1		
5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0		
6	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0		
7	0	0	1	0	0	0	0	0	0	0	0	0	1	0	2		

Appendix 7: Study 2 Post-hoc Comparisons

Table 1. Post-hoc between-group comparisons and effect sizes for age, sleep quality, sleep efficiency, actigraphy sleep time variability, and actigraphy wake time variability.

Age (yrs)		SQ		Sleep Efficiency (%)		ASTV		AWTV		
<i>t(df)</i>	<i>d</i>	<i>t(df)</i>	<i>d</i>	<i>t(df)</i>	<i>d</i>	<i>t(df)</i>	<i>d</i>	<i>t(df)</i>	<i>d</i>	
CON vs FM	-6.67(65)***	-1.42	5.47(82)***	1.20	3.74(50.04)***	.92	-0.29(65)	-0.07	-0.21(65)	-.04
CON vs BD	-2.75(45.54)**	-0.55	3.52(89)**	.73	3.20(42.75)**	.82	-2.19(62)*	-.56	-1.49(62)	-.36
FM vs BD	2.92(59)**	.79	-1.42(75)	-.33	-0.22(59)	-.06	-1.68(59)	-.45	-1.12(59)	-.29

Note: CON= Non-clinical controls; FM= Fibromyalgia participants; BD= Bipolar participants; SQ= Sleep Quality; ASTV= Actigraphy Sleep Time Variability; AWTV= Actigraphy Wake Time Variability.

Post-hoc comparisons were computed using the Student's *t*-test. Effect sizes are represented by Cohen's *d*.

p* < .05; *p* < .01 ****p* < .001.

Appendix 8: The Hypomanic Interpretations Questionnaire
(HIQ; Jones, Mansell & Waller, 2006)

Listed below are situations that you may or may not have ever experienced. For each situation, please circle the letter next to each reason that corresponds to how much that might explain the situation for you. Please check every item for each question. Also, answer whether you have experienced the situation in the last 3 months by circling A (yes) or B (no). Please answer all questions.

A	B	C	D
Not at all	Somewhat	Quite a bit	A great deal
1. If I thought my thoughts were going too fast I would probably think it was because:			
I am intelligent and full of good ideas.			A B C D
There are too many competing tasks for me at present.			A B C D
Have you experienced this situation in the last 3 months?			A=yes B=no
2. If I was on the go so much that other people couldn't keep up with me, I would probably think it was because:			
I am overdoing it and will soon need a rest.			A B C D
I have more stamina than other people.			A B C D
Have you experienced this situation in the last three months?			A=yes B=no
3. If my thoughts were coming so thick and fast that other people couldn't keep up, I would probably think it was because:			
I am full of good ideas and others are too slow.			A B C D
There are too many demands on my time.			A B C D
Have you experienced this situation in the last 3 months?			A=yes B=no
4. If I was feeling 'sped up' inside, I would probably think it was because:			
I am under pressure from work or social demands.			A B C D
I am in good spirits and can take on challenges.			A B C D
Have you experienced this situation in the last 3 months?			A=yes B=no
5. If I felt physically restless and kept moving from one activity to the next, I would probably think it was because:			
I am full of energy and raring to go.			A B C D
There is too much pressure and I need a break.			A B C D
Have you experienced this situation in the last 3 months?			A=yes B=no

6. If I felt impulsive, I would probably think it was because:

I could make rapid decisions and good choices.

A B C D

There are lots of external demands.

A B C D

Have you experienced this situation in the last 3 months?

A=yes B=no

7. If I felt in high spirits and full of energy, I would probably think it was because:

I am a talented person with lots to offer.

A B C D

Things happen to be going well for me at present.

A B C D

Have you experienced this situation in the last 3 months?

A=yes B=no

8. If I woke up earlier than normal and felt full of energy, I would probably think it was because:

I am a happy, positive and energetic person.

A B C D

Something has disrupted my routine.

A B C D

Have you experienced this situation in the last 3 months?

A=yes B=no

9. If I found my thinking was very quick and clear, I would probably think it was because:

There are few distractions at present.

A B C D

I am clever and talented.

A B C D

Have you experienced this situation in the last 3 months?

A=yes B=no

10. If I found that tastes, smells or things I touched seemed more vivid, I would probably think it was because:

It is just a phase and will pass.

A B C D

I am more sensitive and 'tuned in' than other people.

A B C D

Have you experienced this situation in the last 3 months?

A=yes B=no

Appendix 9: The Interpretations of Depression Questionnaire
(IDQ; Jones & Day, 2008)

Listed below are situations that you may or may not have ever experienced. For each situation, please circle the letter next to each reason that corresponds to how much that might explain the situation for you. Please check every item for each question. Also, answer whether you have experienced the situation in the last 3 months by circling A (yes) or B (no). Please answer all questions.

A	B	C	D
Not at all	Somewhat	Quite a bit	A great deal
1. If I felt I couldn't enjoy life as easily as other people, I would probably think it was because:			
Current pressures are distracting me from my interests		A B C D	
I don't get pleasure from anything anymore		A B C D	
Have you experienced this situation in the last 3 months?		A=yes B=no	
2. If I experience guilty feelings even though I may not have done anything particularly wrong I would probably think it was because:			
I am being hard on myself because I under strain at the moment		A B C D	
I am a bad person and deserve to be punished		A B C D	
Have you experienced this situation in the last 3 months?		A=yes B=no	
3. If I have exploded at others and afterwards felt bad about myself I would probably think it was because:			
I am a nasty person		A B C D	
I am under a lot of pressure at the moment		A B C D	
Have you experienced this situation in the last 3 months?		A=yes B=no	
4. If I felt cut off from other people I would probably think it was because:			
I am an insensitive person		A B C D	
Things are difficult at the moment and I have little energy for other things		A B C D	
Have you experienced this situation in the last 3 months?		A=yes B=no	

5. If I had upsetting or bad thoughts going through my mind I would probably think it was because:

I am rather low at present but when things improve the thoughts
will go

A B C D

I am a worthless person to have these type of thoughts

A B C D

Have you experienced this situation in the last 3 months?

A=yes B=no

6. If I felt down on myself I would probably think it was because:

I am a bad person, even towards myself

A B C D

Current problems are leading me to be rather hard on myself

A B C D

Have you experienced this situation in the last 3 months?

A=yes B=no

7. If I felt that the future was bleak and things were unlikely to improve I would probably think it was because:

Situations look bleak, but will change as things improve

A B C D

I am a negative pessimistic person

A B C D

Have you experienced this situation in the last 3 months?

A=yes B=no

8. If there were times when I struggled to control an urge to cry or found myself crying without really understanding why I would probably think it was because:

I am a weak, pathetic, person

A B C D

My difficulties have affected me just at the moment

A B C D

Have you experienced this situation in the last 3 months?

A=yes B=no

9. If I have periods of time when I felt a persistent sense of gloom I would probably think it was because:

I am a failure and a burden to others

A B C D

Things are going wrong for me just at present

A B C D

Have you experienced this situation in the last 3 months?

A=yes B=no

10. If I felt that nothing was working out for me I would probably think it was because:

Too many obstacles are being put in my way at present

A B C D

I struggle to get anything right in my life

A B C D

Have you experienced this situation in the last 3 months?

A=yes B=no

Appendix 10:

The Social Rhythm Metric

(SRM; Monk, Flaherty, Frank et al., 1990)



YOUR

DAILY ROUTINE

The following questionnaire asks you about your daily routines and is to be completed each day over a full week. There are seven sheets, one for each day. Please complete it as accurately as possible.

Example:

7 Have lunch

NO

YES

12:30

AM

PM

SRM

Below is a list of activities that some people do as part of a regular daily routine. Please read each item carefully, and indicate whether or not this activity was done, and if so at what time. Please complete daily.

Day 1

Date: .../.../...

			Clock Time
1	Get out of bed	NO YES	AM PM
2	First contact (in person or by the phone)with another person	NO YES	AM PM
3	Have a morning beverage	NO YES	AM PM
4	Have Breakfast	NO YES	AM PM
5	Go outside for the first time	NO YES	AM PM
6	Start school, work or housework, child/family care	NO YES	AM PM
7	Have lunch	NO YES	AM PM

			Clock Time
8	Take an afternoon nap	NO YES	AM PM
9	Have dinner	NO YES	AM PM
10	Physical exercise	NO YES	AM PM
11	Have a evening snack/drink	NO YES	AM PM
12	Watch evening TV news program	NO YES	AM PM
13	Watch another TV program	NO YES	AM PM
14	Activity A _____	NO YES	AM PM
15	Activity B _____	NO YES	AM PM
16	Return Home (for the last time)	NO YES	AM PM
17	Go to bed	NO YES	AM PM

Appendix 11:

The Hypomanic Personality Scale (HPS; Eckbald & Chapman, 1987)

This questionnaire consists of statements to which you can respond 'true' or 'false'. In each case, please record your answer by selecting the appropriate answer. Please answer as accurately as possible. There are no right or wrong answers, and we expect there to be considerable variation in the way people respond to the items.

1. I consider myself to be pretty much an average kind of person
True ☐ False ☐
2. It would make me nervous to play the clown in front of people
True ☐ False ☐
3. I am frequently so 'hyper' that my friends kiddingly ask me what drug I am on
True ☐ False ☐
4. I think I would make a good nightclub comedian
True ☐ False ☐
5. Sometimes ideas and insights come to me so fast that I cannot express them all
True ☐ False ☐
6. When with groups of people, I usually prefer to let someone else be the centre of attention
True ☐ False ☐
7. In unfamiliar surroundings I am often so assertive and sociable that I surprise myself
True ☐ False ☐
8. There are often times when I am so restless that it is impossible for me to sit still
True ☐ False ☐
9. Many people would consider me to be amusing but somewhat eccentric
True ☐ False ☐
10. When I feel an emotion, I usually feel it with extreme intensity
True ☐ False ☐
11. I am frequently in such high spirits that I can't concentrate on any one thing for long
True ☐ False ☐
12. I have sometimes felt like nothing can happen to me until I do what I am meant to do in life
True ☐ False ☐

13. People often come to me when they need a clever idea
True ☐ False ☐
14. I am no more self-aware than the majority of people
True ☐ False ☐
15. I often feel excited and happy for no apparent reason
True ☐ False ☐
16. I can't imagine that anyone would ever write a book about my life
True ☐ False ☐
17. I am usually in an average sort of mood, not too high and not too low
True ☐ False ☐
18. I often have moods where I feel so energetic and optimistic that I feel I could outperform almost anyone at anything
True ☐ False ☐
19. I have such a wide range of interests that I often don't know what to do next
True ☐ False ☐
20. There have often been times where I have such an excess of energy that I feel little need to sleep at night
True ☐ False ☐
21. My moods do not seem to fluctuate any more than most people's do
True ☐ False ☐
22. I very frequently get into moods where I wish I could be everywhere and do everything at once
True ☐ False ☐
23. I expect someday that I will succeed in several different professions
True ☐ False ☐
24. When I feel very excited and happy, I almost always know the reason why
True ☐ False ☐
25. When I go to a gathering where I don't know anyone, it usually takes me a while to feel comfortable
True ☐ False ☐
26. I think I would make a good actor because I play many roles convincingly
True ☐ False ☐
27. I like to have others think of me as a normal kind of person
True ☐ False ☐

28. I frequently write down the thoughts and insights that come to me especially when I am thinking creatively

True ☐ False ☐

29. I have often persuaded groups of friends to do something really adventurous or crazy

True ☐ False ☐

30. I would really enjoy being a politician on the campaign trail

True ☐ False ☐

31. I can usually slow myself down when I want to

True ☐ False ☐

32. I am considered to be a 'hyper' kind of person

True ☐ False ☐

33. I often get so happy and energetic that I am almost giddy

True ☐ False ☐

34. There are so many fields I could succeed in that it seems a shame to have to pick one

True ☐ False ☐

35. I often get into moods where I feel like many of the rules of life dont apply to me

True ☐ False ☐

36. I find it easy to get others to become sexually interested in me

True ☐ False ☐

37. I seem to be a person whose mood goes up and down easily

True ☐ False ☐

38. I frequently find that my thoughts are racing

True ☐ False ☐

39. I am so good at controlling others that sometimes it scares me

True ☐ False ☐

40. At social gatherings I am usually the 'life of the party'

True ☐ False ☐

41. I do most of my best work during brief periods of intense inspiration

True ☐ False ☐

42. I seem to have an uncommon ability to persuade and inspire others

True ☐ False ☐

43. I have often been so excited about an involving project that I didn't care about eating or sleeping

True ☐ False ☐

44. I frequently get into moods where I feel speeded-up and irritable

True ☐ False ☐

45. I have often felt happy and irritable at the same time

True ☐ False ☐

46. I often get into excited moods where it is almost impossible for me to stop talking

True ☐ False ☐

47. I would rather be an ordinary success in life than a spectacular failure

True ☐ False ☐

48. A hundred years after I'm dead, my achievements will probably have been forgotten

True ☐ False ☐